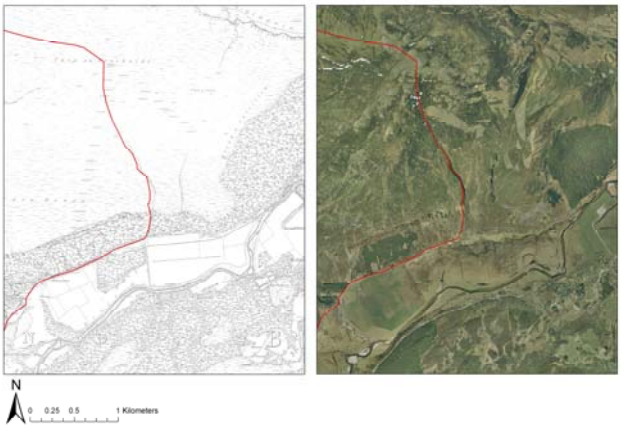
Developing a Regeneration Management Plan for Mar Lodge Estate native woodlands: 2010 - 2030.



Contract to National Trust Scotland

Initial draft: December 2009.

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Background

One of the major initiatives currently being implemented at Mar Lodge Estate is the encouragement of natural regeneration and extension of the native woodland cover in the northern glens of the estate [referred to as the Regeneration Zone]. The work to initiate this process, to date, has largely been based on the reduction of browsing pressure from deer to prevent damage to emerging saplings. There are increasing concerns that the ageing of the remaining pine within this zone means that the 'window' for these trees to provide the seed rain to start this process, is a narrow one and that if not realised very soon the succession process may be lost forever.

Additionally there is now a significant lapse since the last flush of regeneration on the estate so that future woodland may well not have the full representation of tree ages which one would expect to see in a woodland. Another major factor in the successful development of regeneration is providing the right ground conditions for germination and establishment of seedlings. For these issues to be correctly balanced and directed within this zone we need to develop a long-term plan that will identify appropriate measures to achieve our objectives, incorporating a prioritised programme of work needed over the next 20 years.

Objectives and timescale

The objective of this plan is to encourage the re-establishment and spread of native woodland throughout the Mar Lodge Regeneration Zone (see Figure 1) to a range decided, largely, by natural processes such as a natural altitude tree line. This initial plan will last 20 years, beginning 2010.

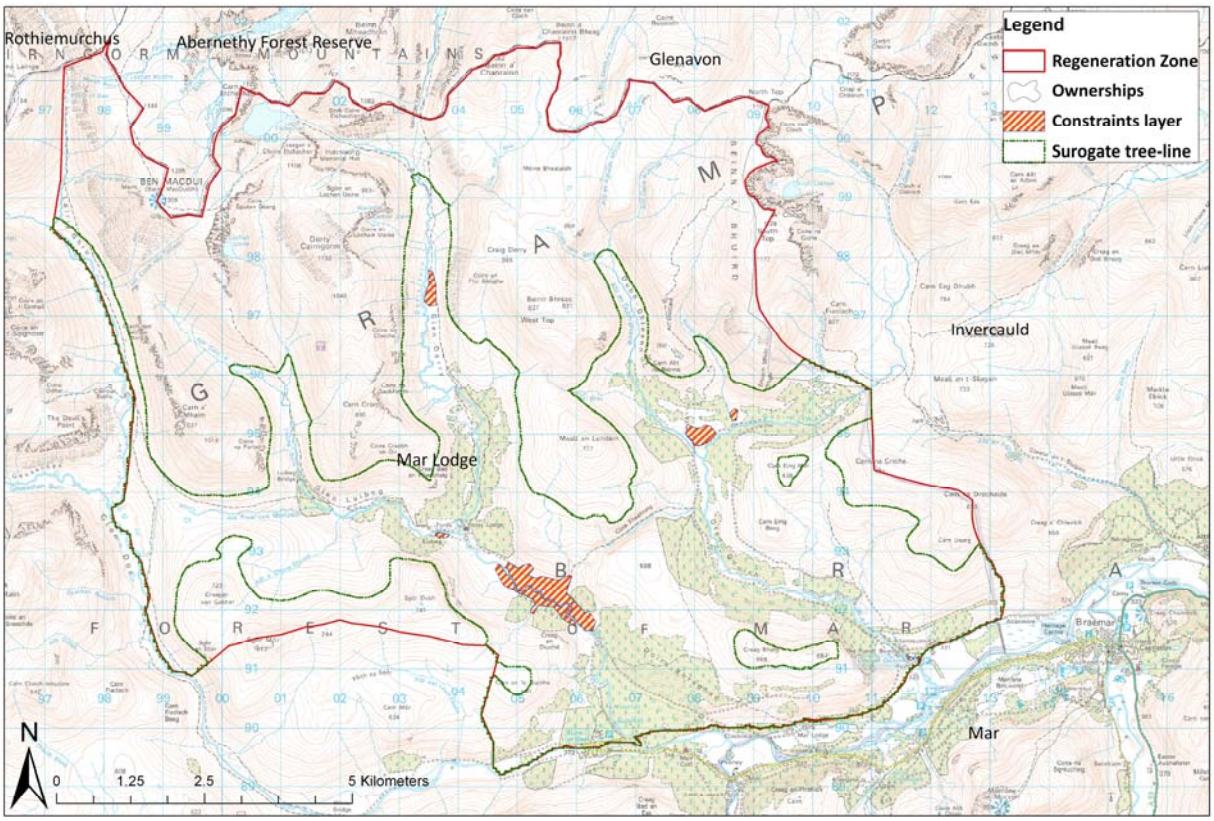

Figure 1 General map of Mar Lodge Regeneration Zone, current highest altitude live tree that designates the live tree-line, and location of constraints that identify the areas that will not be regenerated.

Two hundred year vision

To set the initial 20-year plan into context a 200-year vision has been proposed that represents the end objective for the woodland state. The objective of the 200-year vision is:

"to have established a self-sustaining intimate mix of structurally and compositionally diverse woodland and non-woodland habitats extending from the valley floor to the natural altitudinal limit for tree growth; that are ecologically appropriate for the site and climatic conditions, that increase connectivity between habitats across the landscape and within the site through the development and expansion of habitat networks, and that provide a range of ecological and social services without the need for intensive management."

The natural altitudinal limit for tree growth is difficult to predict for this particular area as no representative examples of truly natural tree-line eco-zone exists within the Mar Lodge boundary. For this initial plan a surrogate altitudinal tree-line has been identified that is based on the current highest altitudinal limit for any live tree within the regeneration plan boundary (Figure 1). This upper-elevation is set at 620 m and it is used to identify the maximum area included in the initial

20 year plan. It is not expected that abundant natural regeneration will occur up to this limit across the entire estate; some open habitats will need to be kept regeneration free, while others are unlikely to regenerate naturally as they are unsuitable for tree growth. Additionally the elevation of the natural tree-line will vary significantly with site conditions, e.g. aspect, slope shape, soils and level of exposure, which the surrogate limit cannot delineate accurately.

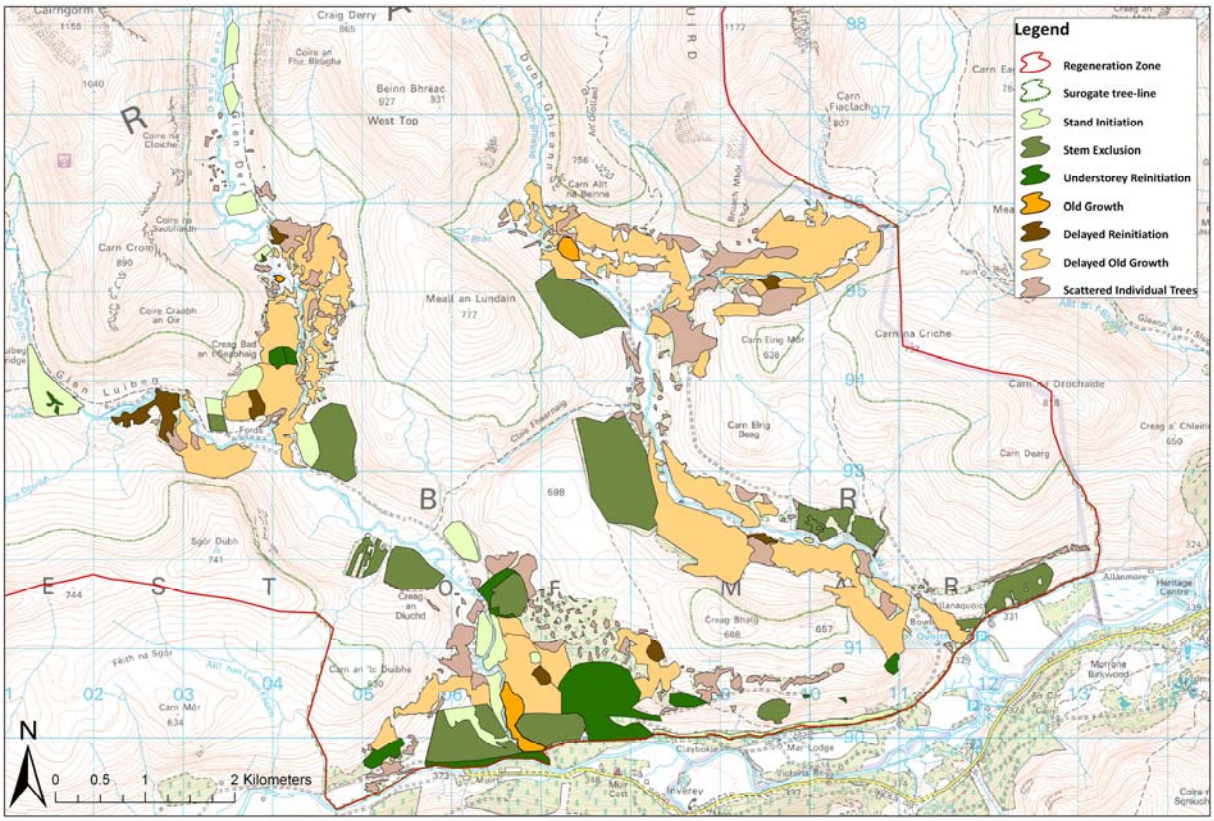

Figure 2 Successional Phases for part of the Mar Lodge Regeneration Zone; see text for details on each of the phases.

Current stand structure

The initial Stand Structure Survey completed at Mar Lodge (Edwards and Davies, 2008a) identified an imbalance in the proportion of the successional pinewood phases (Oliver & Larson, 1996), and a high proportion of phases that were 'degraded' (in the sense that they do not contain the appropriate structural characteristics of the successional stage and therefore cannot supply the function appropriate for the stage) (Figures 2 & 3). The three phases: Delayed Reinitiation, Degraded Old Growth, and Scattered Individual Trees, all have the potential for regeneration recruitment which, when successfully established, would change their designation to Understorey Reinitiation, Old Growth, and Degraded Old Growth respectively.

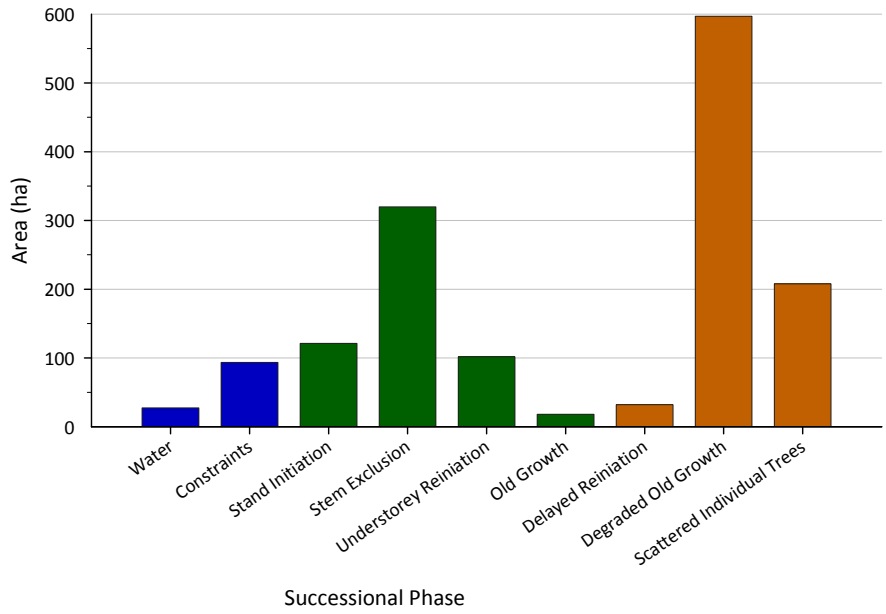

Figure 3 Area of each successional phase recorded by the Stand Structure assessment within the Mar Lodge Regeneration Zone. Blue colour bars indicate non-tree areas, Green bars indicate satisfactory phases, Orange indicate degraded phases.

To create a better balance of successional phases in the landscape, to meet the needs of being called a self-sustaining woodland (Oliver & Larson, 1996), there needs to be an increase in the area of stand initiation and understorey reinitiation, and development of the missing seedling and sapling elements of old growth by encouraging recruitment into the degraded old growth phase. This needs to be phased in over time and not a single cohort of new regeneration across the entire area that can and should have seedlings / trees established upon it. To this end a variety of regeneration methods are necessary, each of which will each lead to a different aged cohort, variation in stem density and species composition.

Current within stand connectivity

Modelling within stand connectivity is based on a GIS-based model from the 'BEETLE' suite of tools developed by Forest Research (see www.forestresearch.gov.uk/habitatnetworks). The model considers how areas of habitat are spatially arranged within the whole landscape, and how species can utilise and disperse between patches of habitat. Part of this model is a focal species tool that utilises habitat requirements and dispersal characteristics to identify functional habitat networks for a given species. The BEETLE accumulated cost distance tool (ACDT) was used to analyse the selected habitat networks within the Mar Lodge Regeneration Zone. This approach negates the need to carry out a vast number of individual species analyses, which is particularly important as data regarding species habitat requirements and dispersal through the landscape is lacking.

Various iterations of the BEETLE modelling approach have been described by Humphrey *et al*. (2004a, b), Watts *et al*. (2004) and Humphrey *et al.* (2005). BEETLE is implemented through a set of modules that represent and process data, as illustrated in Figure 4. There are two input data elements: a **land cover module** and a **focal species module.** The **connectivity module** models the interaction between land cover (particularly woodland Structural Phase (Smith *et al*., 2008) and focal species. This module produces areas identified as habitat, and indicates the probability of movement across the landscape. This analysis allows an assessment of landscape structure and function to identify habitat patches within functional networks.

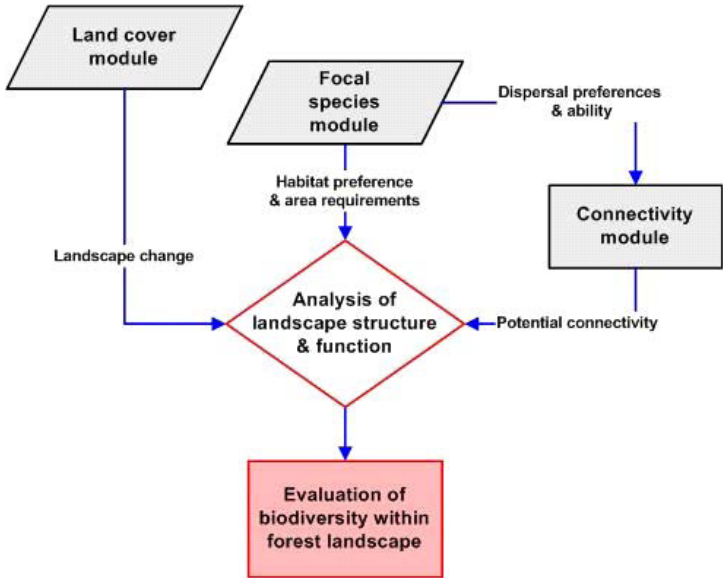

Figure 4 The components of the BEETLE model and relationship between different modules.

The analysis of connectivity in the Mar Lodge Regeneration Zone indicates that a high level of fragmentation exists within the regeneration zone. Potential movement of generalist species within the current woodland resource was used to obtain Figure 5. This indicates areas where these generalists are able to move within the landscape. Any initial regeneration recruitment that occurs within the regeneration zone should aim to increase this connectivity (decrease fragmentation) and increase the functioning of the woodland landscape. This would be achieved by enhancing connectivity within current Mar Lodge woodland, between blocks of woodland in Mar Lodge and between existing networks external to the Estate (Figure 5).

When linked with the aim of returning degraded areas of woodland to functioning habitats, three main objectives of any management operations on site become clear; to identify suitable areas to regenerate in order of priority these are:

1. increase the balance of phases within the Mar Lodge Regeneration Zone by encouraging natural regeneration recruitment within degraded habitats

2. increase habitat connectivity between existing woodland blocks within the Mar Lodge Regeneration Zone

3. increase the connectivity between Mar Lodge and the wider Cairngorm network by linking with external blocks of existing woodland

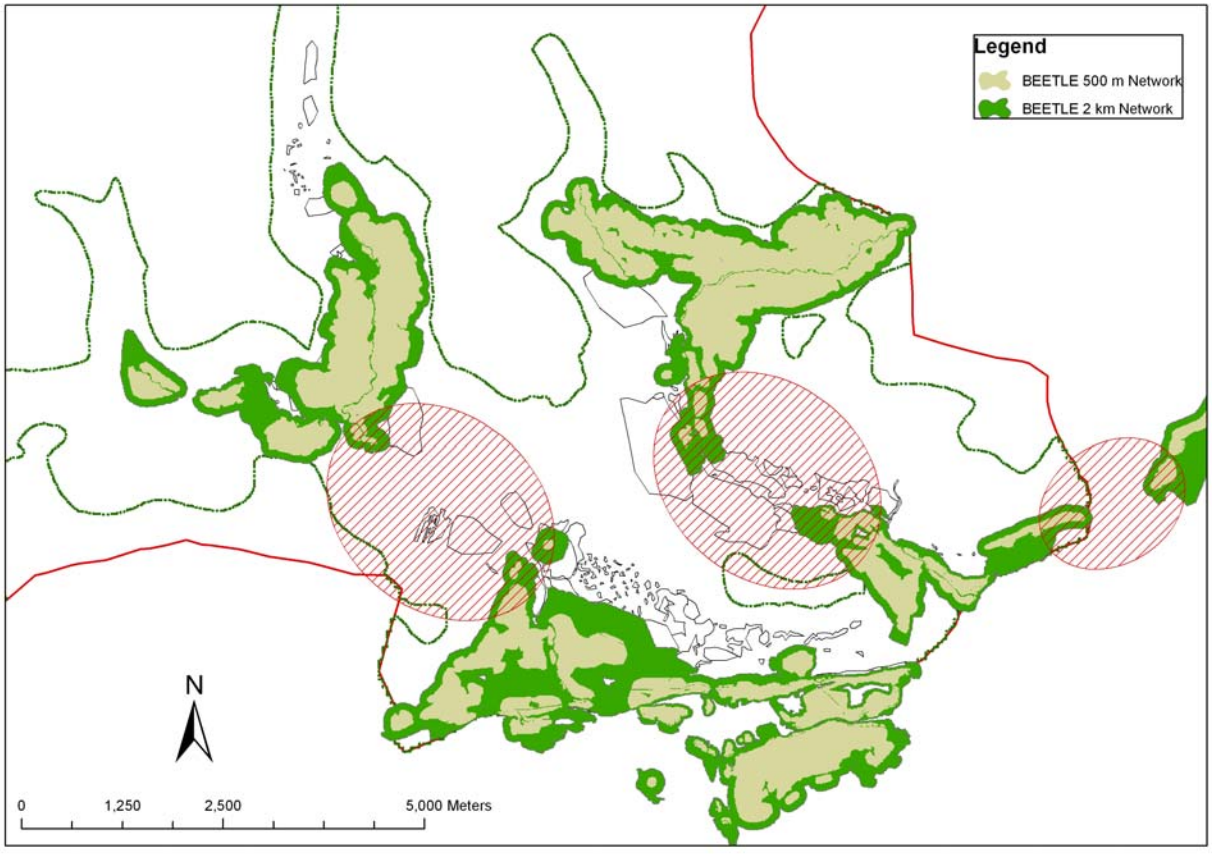

Figure 5 Connectivity map for generalist species over two dispersal ranges; 2 km (for wide dispersing species) and 500 m (for short dispersing species). This map reveals the isolated nature of Dubh Ghleann from Glen Quoich and Glen Derry/Luibeg; and Glen Derry/Luibeg from all other blocks. Focal areas for decreasing fragmentation are indicated in red hatching.

Suitable Woodland Habitats

Data collected for mapping National Vegetation Classification (NVC) habitats (Rodwell, 1991) in Mar Lodge was used to generate spatial suitability maps for woodland habitats across the regeneration zone (Figure 6 and 7). These maps illustrate the potential woodland habitats that could grow in the regeneration zone based on an analysis of soil moisture and soil nutrient regimes (Ray, 2001) and subject to further modification by climate. Currently wooded areas were not included in the analysis but are assumed to be suitable. Over the majority of the lower elevations in Mar Lodge NVC W18 is the principle woodland habitat. This is shown in three sub-categories in figure 7; *W18 Very Suitable*, *W18 Historic Suitable*, *W18 Suitable*.

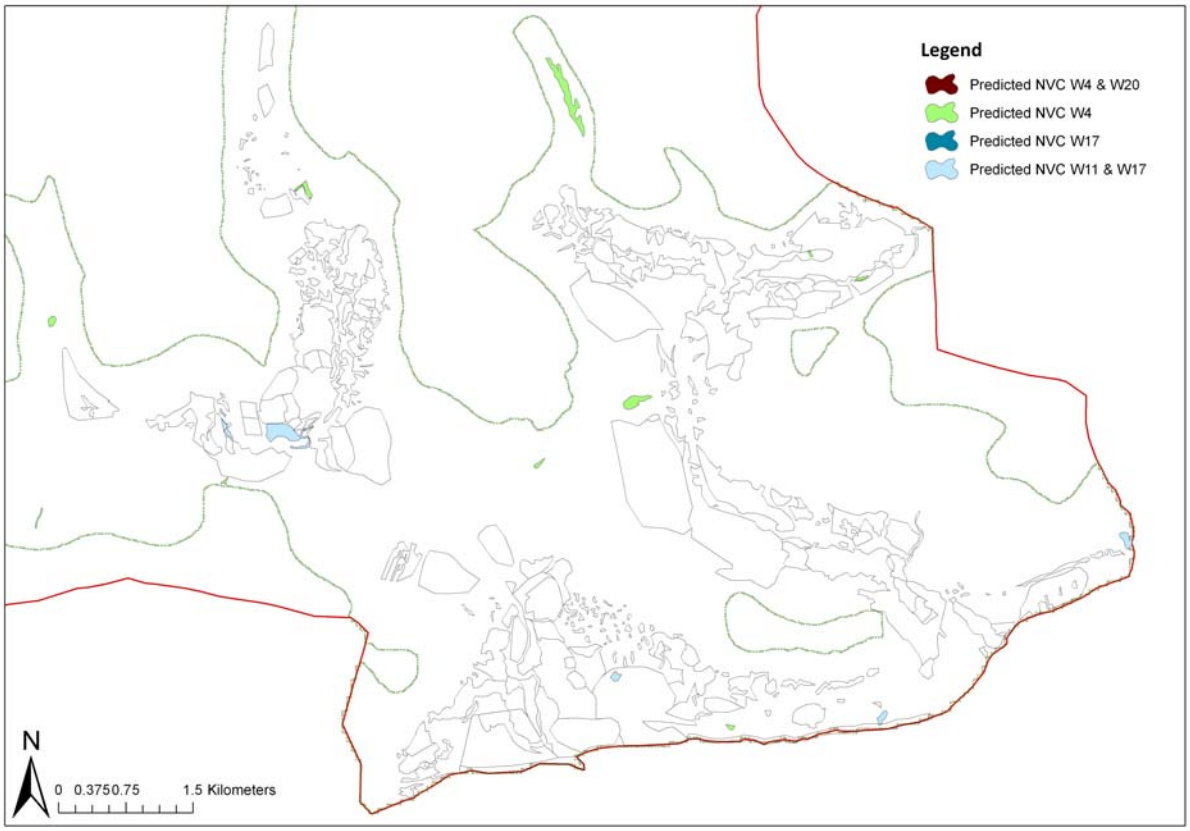

Figure 6 predicted areas suitable for creation of NVC woodland habitats not currently present in the Mar Lodge Regeneration Zone.

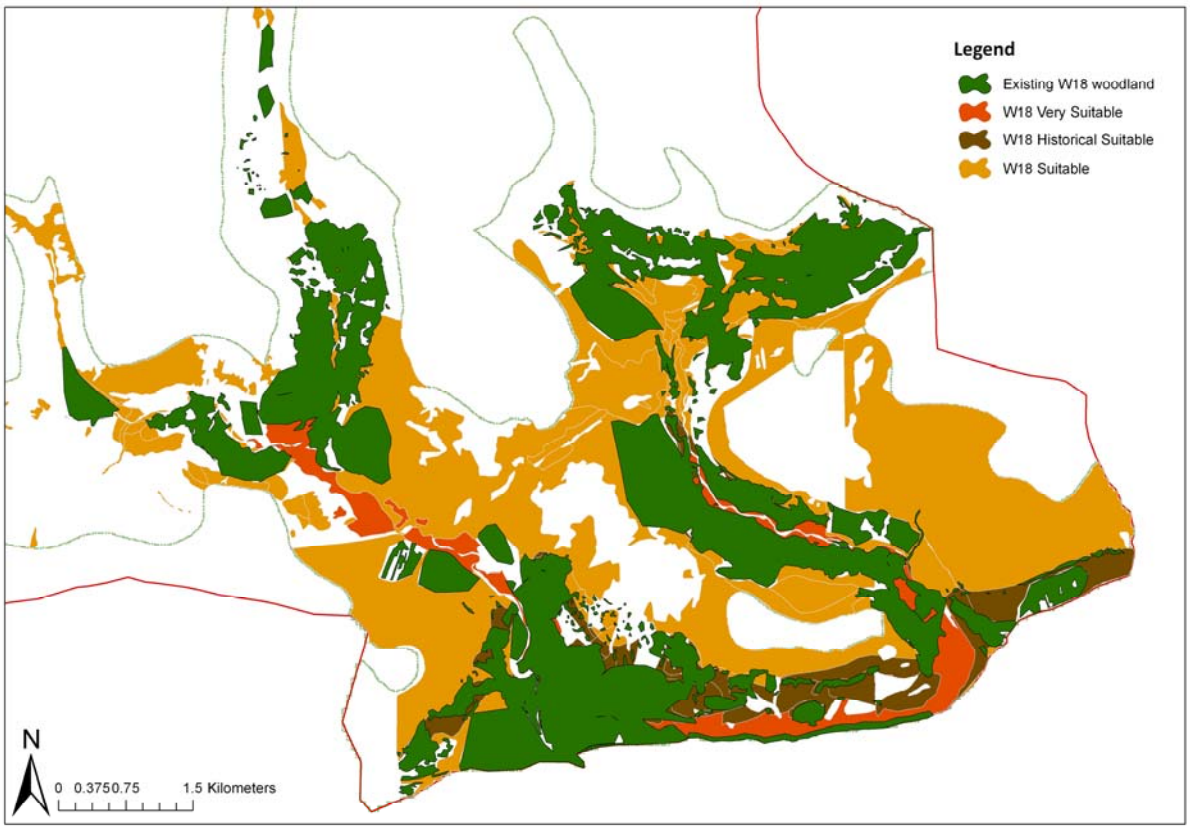

Figure 7 Suitability map for expansion of NVC W18 woodland.

The *W18 Very Suitable* class is non-wooded habitat that has a current vegetation sward containing woodland species. Establishing new woodland (by artificial or natural regeneration) on these sites would lead to creating functioning W18 habitat most rapidly, and should form part of the priority areas for any initial establishment in the 20-year plan.

W18 Historic Suitable areas are located on sites that the OS first edition maps of 1840 – 80 indicate as being wooded in that period (http://geo.nls.uk/os6inch/); subsequent felling has left small groups of remnant trees and isolated individuals (Figure 8). Expansion of the current woodland onto these sites is likely in many areas where seed trees are within seed dispersal distances, but on the boundary between Mar Lodge and neighbouring Estate Invercauld (grid ref: NO129919) few remaining parent trees remain and artificial establishment techniques will be required.

The last sub-category *W18 Suitable* indicates all the remaining non-wooded habitat within the 620 m surrogate tree-line that is suitable for growing W18 pinewood habitat. Some of this area will be gradually occupied by advancing natural regeneration as continued pressure on deer browsing allows seedlings to establish and grow successfully. Seedling height growth rates will be slow and the seedlings vulnerable to damage for many years. Existing height increments on Mar Lodge

range between 8.9 cm yr^{-1} (± 0.4) and 15.6 cm yr^{-1} (± 0.9) for Scots pine, but can be as low as 0.4 cm yr^{-1} in some circumstances even when protected from browsing (Rao, 2008). This indicates that success in terms of achieving seedling establishment will need to be measured over many years, and the transition of seedlings (< 1.3 m height) into saplings (> 1.3 m height but < 7 cm dbh) may take several decades.

In some areas as the upper elevation for normal tree growth is reached, a transition to krumholz growth then montane scrub and above that an alpine zones will develop. Typically the montane scrub would be composed of *Betula nana*, *Juniperus communis* and a range of montane willows *e.g. Salix herbacea, S. myrsinites, S. arbuscula, S. lanata, S phylicifolia, S. Lapponum and S. reticulata.* Interrogation of Figure 7 can help denote the potential areas of the regeneration zone that are suitable for expanding or establishing of tree-line woodland. These will be areas where W18 suitable abuts the surrogate tree-line. The area below the current highest live tree (indicated as current tree-line) is land that could be occupied by a mosaic of woodland and open habitats.

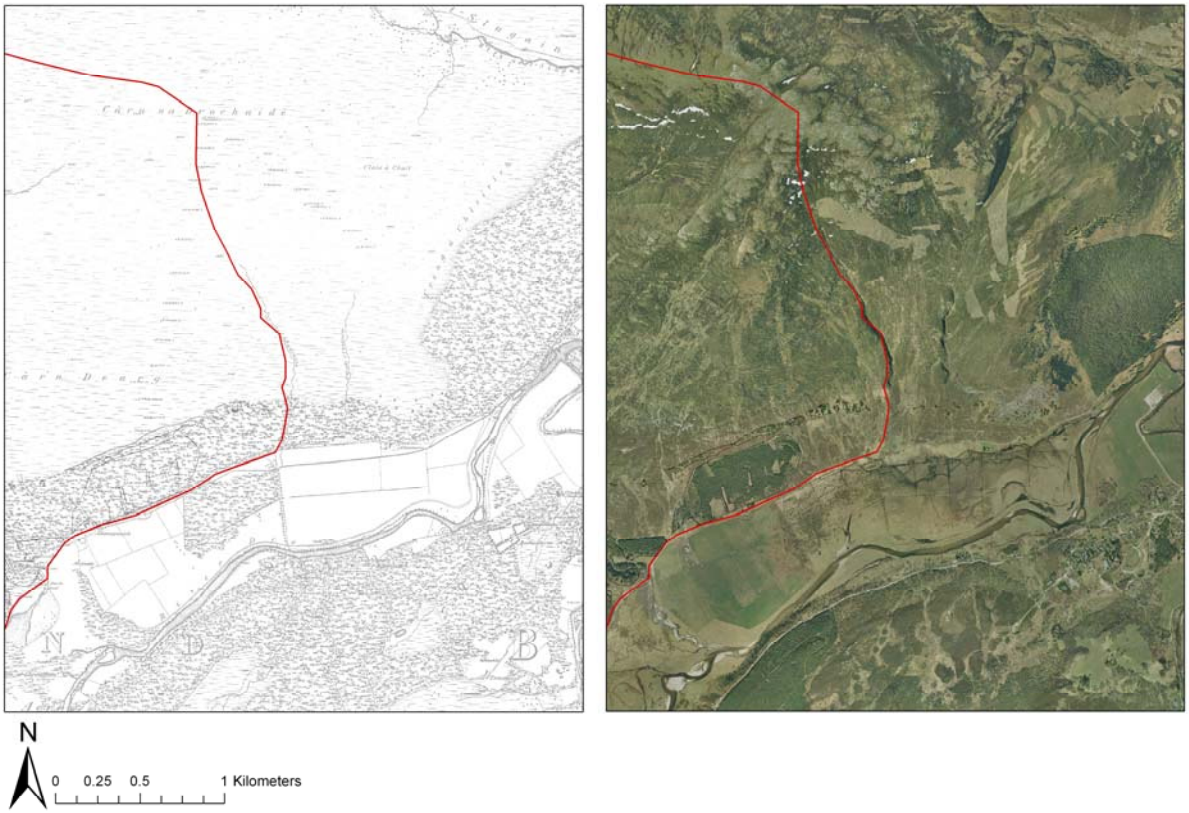

Figure 8 (left) First Edition OS 1940's – 1980's one-inch map series showing historic woodland cover and (right) aerial photograph of current woodland between the Mar Lodge Estate and Invercauld Estate boundary at Grid ref NO129919.

Regeneration techniques

A variety of regeneration methods are necessary, each of which will each lead to a different aged cohort. **Artificial regeneration** will give quick gains in establishing new woodland habitat through prompt seedling growth, particularly of missing or underrepresented species, and will create new connections within the regeneration zone halting the fragmentation of valuable habitat. **Encouraged natural regeneration** recruitment will use a range of appropriate disturbance techniques (e.g. scarification, harrowing, vegetation control) in areas where seed dispersal is likely to lead to high densities of recruitment close to current parent trees. This will encourage the establishment of the missing seedling element within the current Degraded Old Growth and Delayed Reinitiation stages, ensuring the development of this important late successional phase. **Natural regeneration** recruitment at variable densities and variable rates of establishment will occur in appropriate areas through the continued culling of both red and roe deer to very low densities. It is anticipated this will promote recruitment of a range of tree species at slower rate than other methods, but within locations not immediately predictable or controllable. This method is therefore useful in establishing recruitment that leads to the variability of stand structure and species composition beyond the initial 20-year plan.

Artificial regeneration

Planting can be a rapid and successful technique to establish native trees in areas where seed sources are low or absent for encouraging natural regeneration (Rodwell & Patterson, 1994), or rapid establishment of a woodland habitat is the primary aim. Several areas of the regeneration zone should be considered for artificial regeneration, these are indicated on Figure 9.

Any planting that is undertaken should follow best practice (Tabbush, 1988; Aldhous, 1994; Mason, 1999; Morgan, 1999) as currently provided by the Forest Management Decision Support Tools (soon to be available to external FC users via the Forest Research web site http://www.forestresearch.gov.uk/fr/infd-5uwfk4). Artificial regeneration will require planning of the following stages:

a. seed collection (or roots for Aspen, shoot cuttings for Salix)
b. nursery plant production
c. site cultivation
d. protection from browsers
e. fertiliser application on appropriate site types
f. control of weed competition

Example establishment best practice outputs for the working circle areas suggested for artificial regeneration are attached to the end of each working circle section. These are included to show the type of information available and decisions that need to be made when drawing-up detailed

planning proposals for each site. Detailed planning of each site will need to be completed when better soils information is available, this should included a landscape assessment of the positioning and potential impact of fences, species choice and ground preparation.

In some of the existing fenced areas, protection for tree seedlings is available at present and should be capitalised upon to establish under-representative species.

Encouraged Natural regeneration

To increase the rate of regeneration recruitment, reduce the incidence of browsing damage and increase the rate of incremental growth, some method of ground disturbance coupled with an appropriate level of protection will be required (Nixon & Worrell, 1999; Edwards & Davies, 2008b). Stimulating natural regeneration within existing woodland areas, where seed is most abundant, should be initiated through scarification. There are several suitable scarification tools that are available for this work element including powered and non-powered TTS Delta scarifiers, excavator base unit with bucket attachment and horse pulled harrow or log with snags.

Scarification will be most successful where the soils are dry and humus layers are shallow, normally on the tops of knolls, on steeper slopes or at the edge of river and stream banks. Any scarification that is considered for encouraging Scots pine must be within dispersal distance from parent trees with viable seed, and should be timed to coincide with an abundant seed year. Ground disturbance will also stimulate a response from the vegetation on site, and seed bed conditions will remain ideal for regeneration recruitment for 2 – 3 years only.

Several areas of the regeneration zone should be considered for assisted natural regeneration, these are indicated on Figure 9.

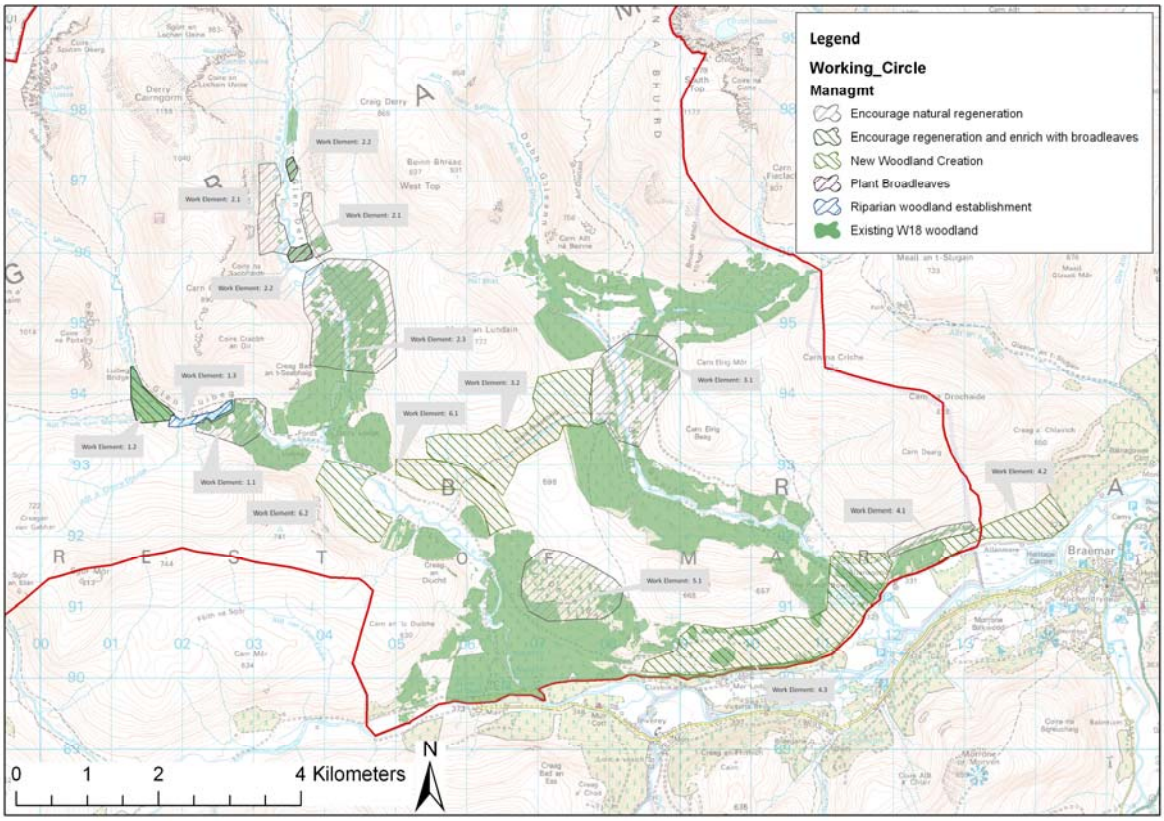

Figure 9 general location of the working circles with the Mar Lodge Regeneration Zone. Each working circle will be the focus for detailed work in a set period of time during the 20 year plan.

Natural regeneration

Natural regeneration is being recruited at a slow rate and low density over selected parts of the regeneration zone (see Edwards and Davies, 2008a, 2008b), and this is anticipated to continue during and after the initial 20-year management plan. High levels of browsing damage had been recorded on seedlings within the regeneration zone, and assessments of seedling growth indicate height increment is slow (Rao, 2008). Protection of seedlings from browsing will allow height increment / growth to increase and promote establishment in a variety of locations.

Natural regeneration is likely to increase in abundance and suffer less from browsing damage in areas that are being protected as part of the detailed management of one or more of the sub-zones. Current advanced natural regeneration within these protected areas will benefit immediately from increased protection, expansion of the area under new regeneration will occur slowly as vegetation changes make new habitats suitable for seed germination and seedling growth. The areas most likely to regenerate first are the dry heathland communities ((e.g. NVC H12) close to existing seed bearing parent trees. In preference to stretching resources and attempting to protect all the areas suitable for regeneration at the same time, deer culling effort should be concentrated in specific areas to protect seedlings and allow establishment to occur

rapidly. Approximately 4,407 ha is suitable for woodland habitat within Mar Lodge below the tree-line, but only a proportion of that area should be wooded; open habitats need to be maintained (Figure 10).

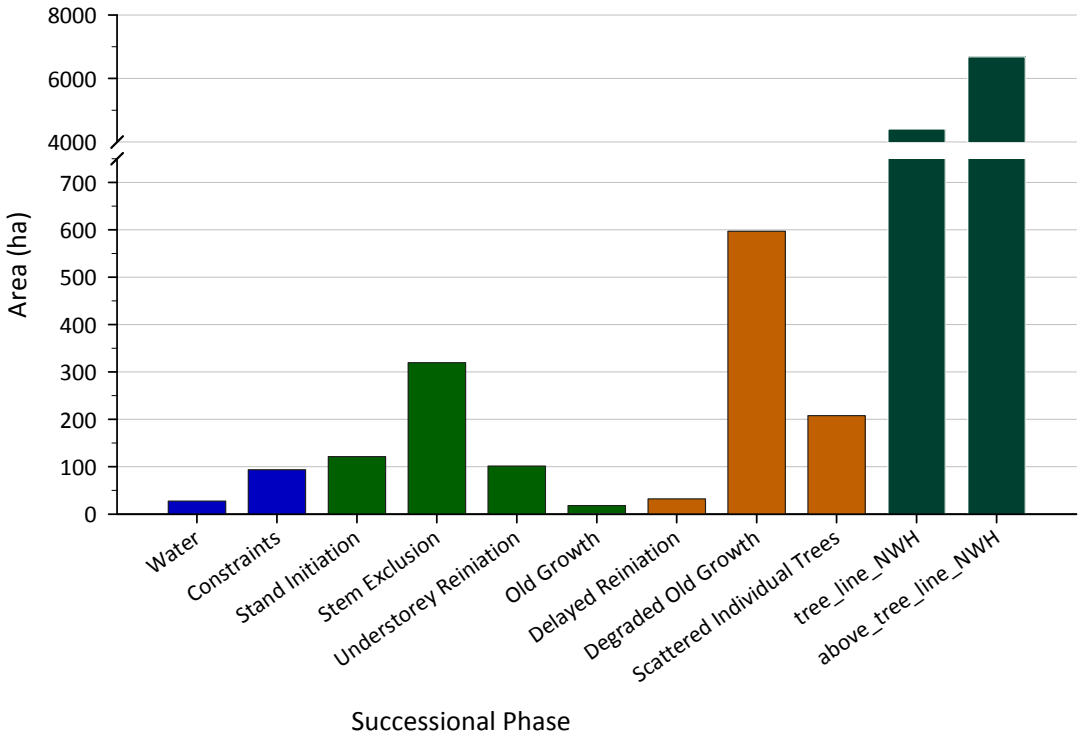

Figure 10 potential area of land for woodland expansion. '*tree_line_NWH*' is the area of land below the current surrogate tree line, '*above_tree_line_NWH*' is the area of land above the tree-line that is likely to remain non-wooded.

Working circles

Rather than attempting to regenerate all of the areas that are appropriate for woodland habitat improvement or creation within the current Mar Lodge Estate Regeneration Zone all at once, which would require substantial investment in resources, six **working circles** have been identified for specific attention. Developing woodland habitat in these areas will give 'quick wins' and early ecological returns to the project. Deer culling can then be focused more easily within specific areas to ensure any growing seedlings are protected and given a suitably browse free period to establish. Combined they will increase the connectivity of the entire Mar Lodge existing woodland area, and link it to the more extensive Deeside woodland habitat network. Each of the working circles are shown in figure 9 and are dealt with in detail in the following sections.

Within each working circle there are specific elements of work that need to be performed to achieve the objectives of this plan.

Priority and timeline

A priority ranking system, that compares all pairs of possible work elements in order and allocates a priority to one of each pair, was used to decide which working circle should be treated in priority to the others. This ranking was then used to group together working circles to be allocated into four 5-year periods within the overall 20 year plan, as trying to achieve all objectives would be impossible. Slight modification of priority ranking was made to element 4.1 and 1.3 to fit with the timing of adjacent work elements. Table 1 shows the results of this ranking and time-line allocation.

Table 1. work elements, time-line and expected durations for all the Work Circles in the Mar Lodge Regeneration Zone.

Work element	Priority ranking score (out of 14)	Time-line for starting	Calendar period	Expected duration
2.1	1	First five year period	2010 – 2015	10
2.3	=2	First five year period	2010 – 2015	10
3.1	=2	First five year period	2010 – 2015	8
5.1	=2	First five year period	2010 – 2015	8
1.1	6	Second five year period	2016 – 2020	5
1.2	7	Second five year period	2016 – 2020	4, 11
2.2	8	Second five year period	2016 – 2020	7
1.3	10	Second five year period	2016 – 2020	11
4.1	5	Third five year period	2021 – 2025	8
4.3	9	Third five year period	2021 – 2025	3, 10
4.2	11	Third five year period	2021 – 2025	7
6.2	12	Fourth five year period	2026 – 2030	7
6.1	13	Fourth five year period	2026 – 2030	7
3.2	14	Fourth five year period	2026 – 2030	7

Working circle 1: Glen Luibeg.

Located in Glen Luibeg between the existing plantation at NO014938 and the existing native woodland at NO025936. Three main elements of work are required.

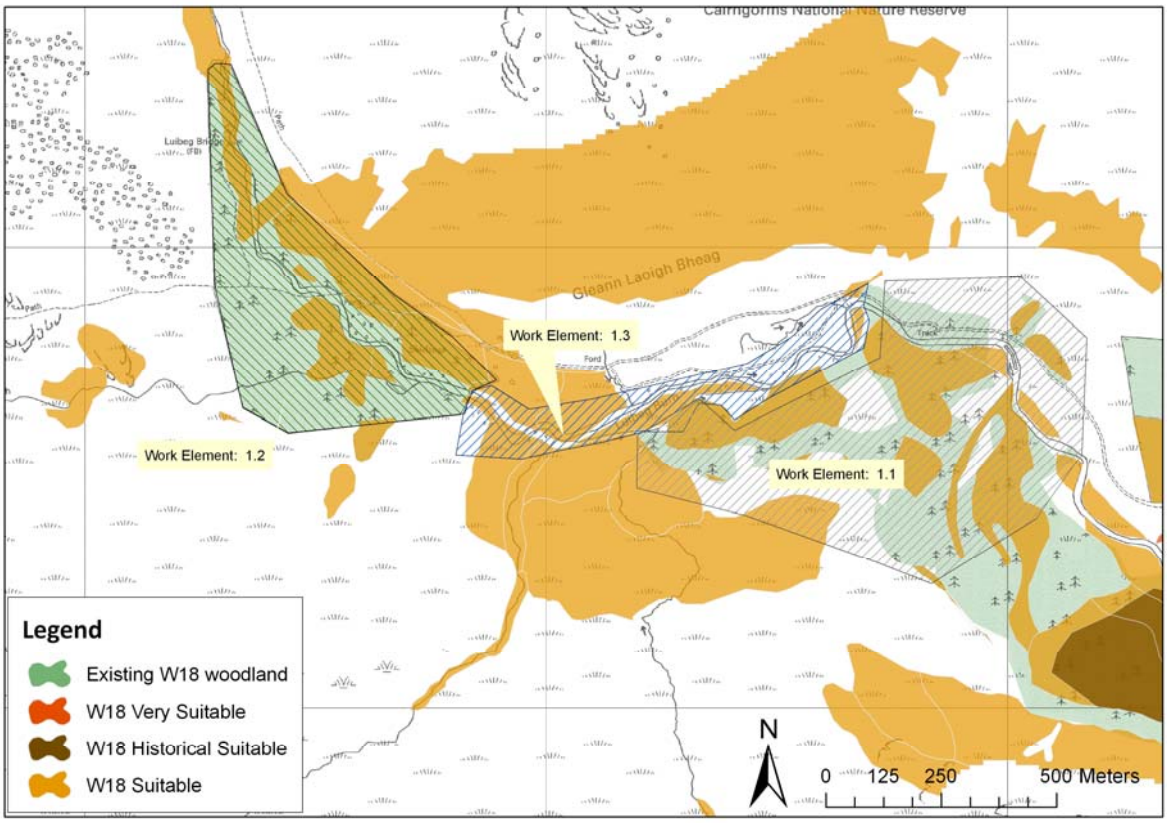

Figure 11 Working Circle 1: Glen Luibeg.

1.1 Encourage natural regeneration recruitment around existing parent trees by locally intensive site disturbance to create seed bed conditions within 30m of seed source on knolls and driers soils. Avoid the wet pockets and peaty soils that can be found between the dry podsols. Heather may need to be reduced in height before locally intensive site disturbance can be successfully applied; this can be by mechanical swiping or controlled burning. Disturbance needs to be vigorous enough to remove the litter and humus layers to expose the soil horizons below.

Site disturbance should be applied either in the late Autumn (after vegetation growth has ceased) or in early April (before seed fall peaks in May). Disturbance after peak seed fall will reduce the probability of germination and allow disturbed ground to become re-vegetated before the next seed dispersal period.

Suitable protection (ideally fencing) will be required for 20 - 30 years to enable seedlings to establish beyond browsing height.

1.2 Supplement existing Scots pine natural regeneration recruitment around existing trees within a deer exclosure by planting broadleaved tree species missing from the habitat. These species should include *Betula pendula,* on better soils, *Sorbus aucuparia*, and *Betula pubescence* on non-heather dominated areas; and *Salix*, and *Alnus glutinosa* in suitable wetter locations next to the stream side.

A local seed source for each species will need be found, and seed will need to be collected at least one year in advance of raising in a tree nursery. A choice of cell grown or bare root stock will be available depending on the supplying nursery. Cell grown stock will be more costly to transport and handle but can grow taller in the initial years than bare root transplants. See Morgan (1999) for details.

Mounding should be used to create raised planting positions for all species but the *Alnus* and *Salix*. Alnus should be notch planted directly into the soil, while Salix shoot cuttings from locally sourced plants can be struck directly into the soil.

Mar Lodge is located in the Cold climatic zone (see Morgan (1999), Figure 6.5). Therefore back-end planting of bare-root stock is not recommended; all planting of bare-root stock should be undertaken in the period March – May. Containerised or cell grown stock should be planted in the same period, with the possibility of extending the planting period into later May in some circumstances. Planting of cell grown stock can also be started in late September (after plants have hardened-off) until late October, but sites prone to early frost could suffer frost heave and should not be planted late into the back-end.

1.3 establish an area of riparian woodland to link the outlying exclosure with the existing native woodland. The same species and plant types can be used as within the exclosure. Protection of the newly planted trees will be required if they are to be expected to survive; extending the existing fence should be considered.

Working circle 2: Upper Glen Derry.

Located on the east facing slopes at NO032966 and west facing slopes at NO040960, and the general area of native pinewood at NO044949. Two main elements of work are required.

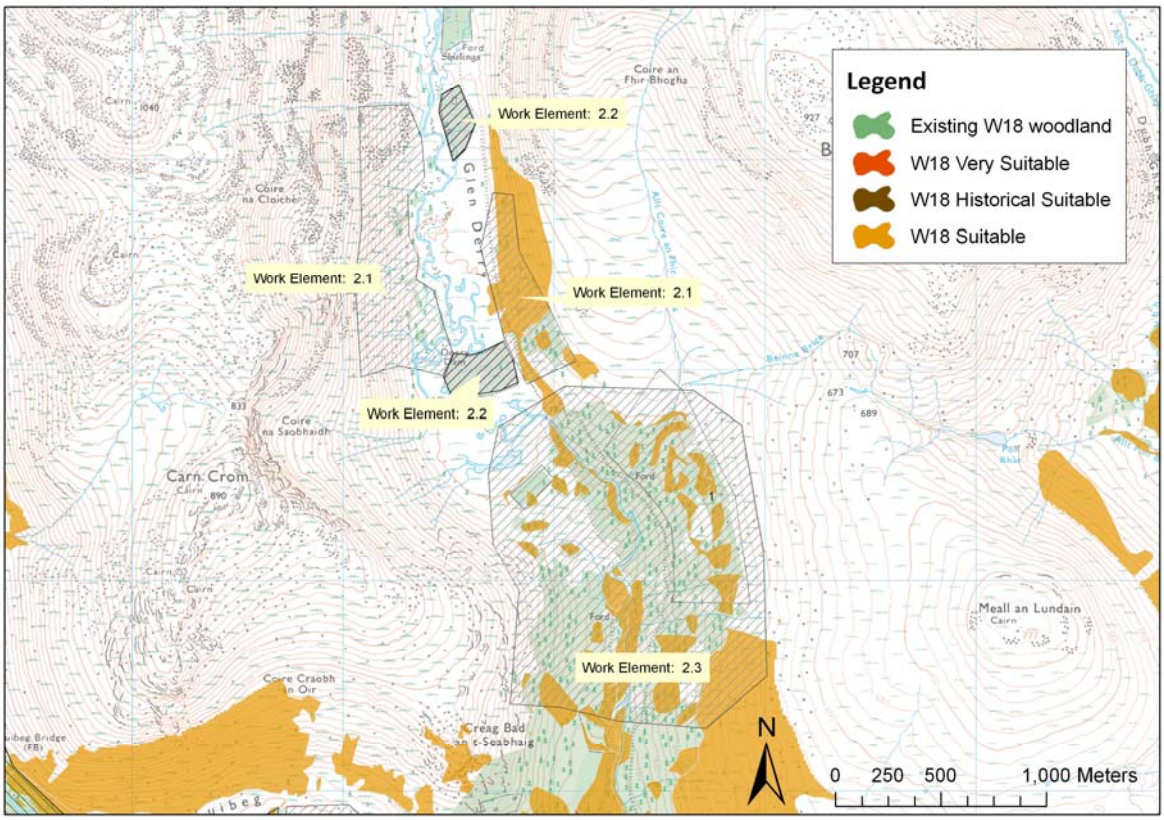

Figure 12 Working Circle 2: Upper Glen Derry.

2.1 Current research work with St Andrews University and AOC Archaeology have identified the solitary isolated Scots pine trees to be amongst the oldest recorded live Scots pine in Scotland (R Wilson pers comm.). The current distribution in northern Glen Derry suggests a declining population of mature and over mature trees that have no associated younger trees or regeneration to ensure replacement of the habitat when these trees senesce. Fenced exclosures in the area (at NO036959, NO035972, and NO035978) have increasing regeneration recruitment but growth is slow. Further fencing and locally intensive site disturbance is recommended, on areas where there is a suitable depth of soil, to encourage more recruitment in and around the existing mature trees. On these scree slopes natural regeneration is likely develop very slowly and will require extended periods of protection compared with more suitable habitats. Two fence rotations may be required before seedlings get above a safe height or attain a safe diameter to be resistant to browse damage.

2.2 Broadleaved species appropriate for the area (i.e. *Alnus glutinosa, Salix spp* (Rodwell & Patterson, 1994)) should be notch planted in the existing exclosures to provide a seed source for future regeneration and expansion of the woodland area.

2.3 Encourage natural regeneration recruitment around existing parent trees (especially NO042956) by locally intensive site disturbance to create seed bed conditions within 30m of seed sources on knolls and driers soils. Avoid the wet pockets and peaty soils that can be found between the dry podsols. Heather may need to be reduced in height before locally intensive site disturbance can be successfully applied; this can be by mechanical swiping or controlled burning. Disturbance needs to be vigorous enough to remove the litter and humus layers to expose the soil horizons below.

Site disturbance should be applied either in the late Autumn (after vegetation growth has ceased) or in early April (before seed fall peaks in May). Disturbance after peak seed fall will reduce the probability of germination and allow disturbed ground to become re-vegetated before the next seed dispersal period.

Suitable protection (ideally fencing) will be required for 20 - 30 years to enable seedlings to establish beyond browsing height.

Working circle 3: Dubh Ghleann.

Located at the junction between Dubh Ghleann and Glen Quoich within existing native woodland at NO083941, and through the pass between NO076940 and NO060930 (Clais Fhearnaig). Two main elements of work are required.

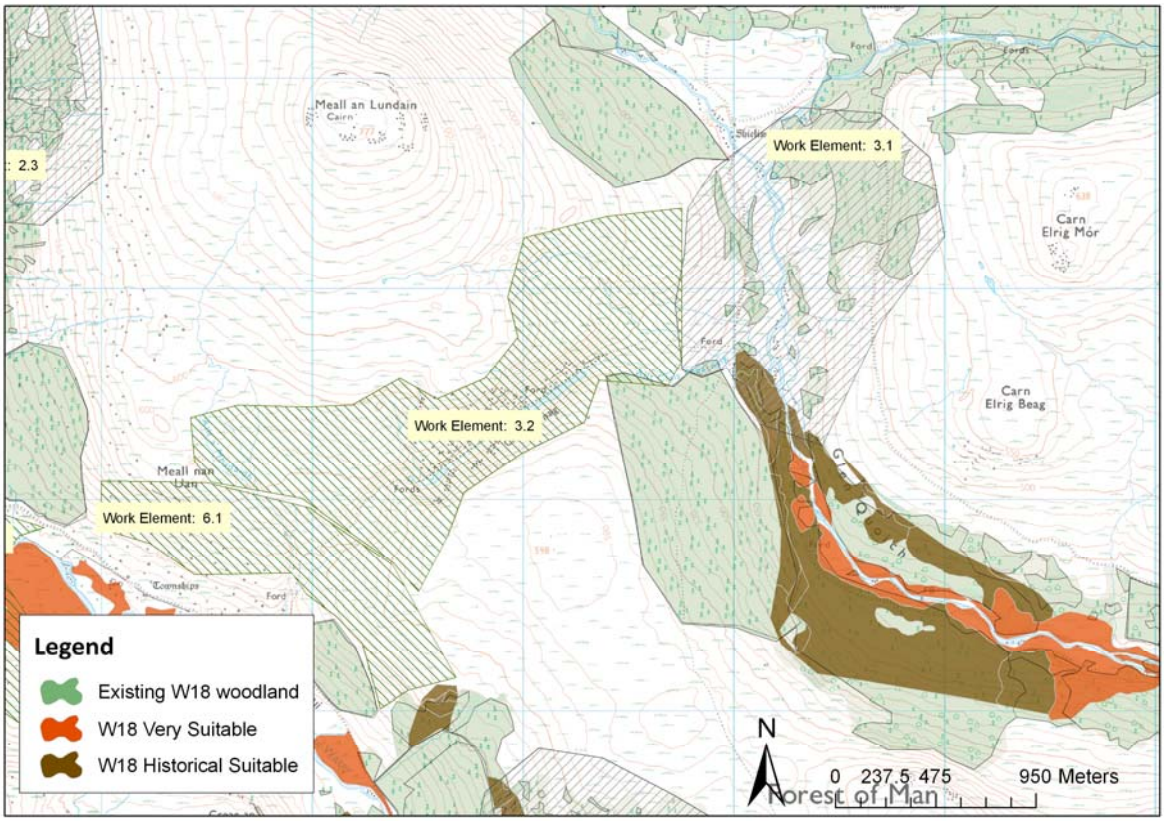

Figure 13 Working Circle 3: Dubh Ghleann.

3.1 Encourage natural regeneration recruitment around existing parent trees (especially NO083941) by locally intensive site disturbance to create seed bed conditions within 30m of seed source on knolls and driers soils. Avoid the wet pockets and peaty soils that can be found between the dry podsols. Heather may need to be reduced in height before locally intensive site disturbance can be successfully applied; this can be by mechanical swiping or controlled burning. Disturbance needs to be vigorous enough to remove the litter and humus layers to expose the soil horizons below.

Site disturbance should be applied either in the late Autumn (after vegetation growth has ceased) or in early April (before seed fall peaks in May). Disturbance after peak seed fall will reduce the probability of germination and allow disturbed ground to become re-vegetated before the next seed dispersal period.

Suitable protection (ideally fencing) will be required for 20 - 30 years to enable seedlings to establish beyond browsing height.

3.2 Establish several areas of new native woodland between NO076940 and NO060930; through the pass known as Clais Fhearnaig. This will join the Glen Derry/Luibeg and Glen Quoich/Dubh Ghleann habitats and create a habitat network in the upper Mar Lodge area. These small areas of new planting will act as islands of seed bearing trees for future natural regeneration recruitment and expansion of the woodland area. This is a complicated area with a path, stream and small Lochan, and steep sided north and south facing slopes. Initial planting should concentrate at either end of the pass.

A local seed source for each species will need be found, and seed will need to be collected at least one year in advance of raising in a tree nursery. A choice of cell grown or bare root stock will be available depending on the supplying nursery. Cell grown stock will be more costly to transport and handle but can grow taller in the initial years than bare root transplants. See Morgan (1999) for details. Scots pine should be raised as two-year old undercuts (1u1) to develop good root formation.

Mounding should be used to create raised planting positions for all species but the *Alnus* and *Salix*. Alnus should be notch planted directly into the soil, while Salix shoot cuttings from locally sourced plants can be struck directly into the soil.

Mar Lodge is located in the Cold climatic zone (see Morgan (1999), Figure 6.5). Therefore back-end planting of bare-root stock is not recommended; all planting of bare-root stock should be undertaken in the period March – May. Containerised or cell grown stock should be planted in the same period, with the possibility of extending the planting period into later May in some circumstances. Planting of cell grown stock can also be started in late September (after plants have hardened-off) until late October, but sites prone to early frost could suffer frost heave and should not be planted late into the back-end.

Scots pine will benefit from an application of phosphate fertiliser at the time of planting. A rate of 60 g ha^{-1} will be sufficient to increase plant survival and early growth and ensure rapid establishment.

Working circle 4: Southern Glen Quoich.

Located on the south facing slopes at NO107905, NO118915 and NO129919. Three main elements of work are required.

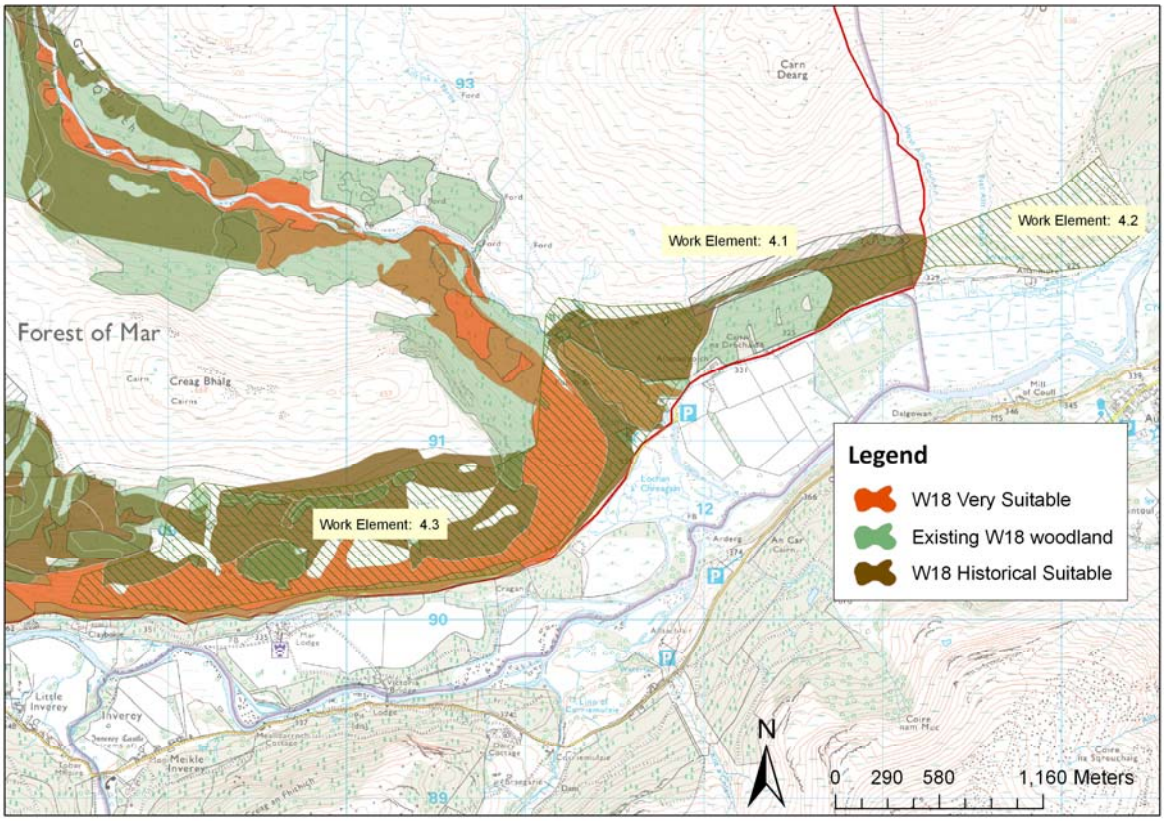

Figure 14 Working Circle 4: southern Glen Quoich.

4.1 encourage natural regeneration recruitment around existing parent trees (between NO119917 and NO131921) by locally intensive site disturbance to create seed bed conditions within 30m of seed source on knolls and driers soils. Avoid the wet pockets and peaty soils that can be found between the dry podsols. Heather may need to be reduced in height before locally intensive site disturbance can be successfully applied; this can be by mechanical swiping or controlled burning. Disturbance needs to be vigorous enough to remove the litter and humus layers to expose the soil horizons below.

Site disturbance should be applied either in the late Autumn (after vegetation growth has ceased) or in early April (before seed fall peaks in May (Edwards, in prep)). Disturbance after peak seed fall will reduce the probability of germination and allow disturbed ground to become re-vegetated before the next seed dispersal period.

Suitable protection (ideally fencing) will be required for 20 - 30 years to enable seedlings to establish beyond browsing height.

4.2 Establish an area of new native woodland from the existing plantation (NO123916) westwards towards the woodland on Invercauld estate (NO146927). This will re-form a habitat network connection that has been lost since the early 1900's (see Figure 8), and allow species to move between the existing Mar Lodge native woodlands and the wider upper Deeside network.

4.3 Combine natural regeneration recruitment with new native woodland creation along the predominately south facing slopes either side of the existing woodland at the Linn of Quoich (NO117911). Use locally intensive site disturbance within 50 m of the existing woodland to stimulate Scots pine natural regeneration recruitment, particularly around the low density and isolated parent trees at NO112916, NO099906, NO094906 and NO088906. Establish artificial regeneration west of the Linn of Quoich to link with existing woodland and natural regeneration at NO095904, and east to link with existing plantation at Allanaquoich (NO123916).

Working circle 5: Glen Lui.

Located on the south west facing slope of Doire Bhraghad at NO074912. One main element of work is required.

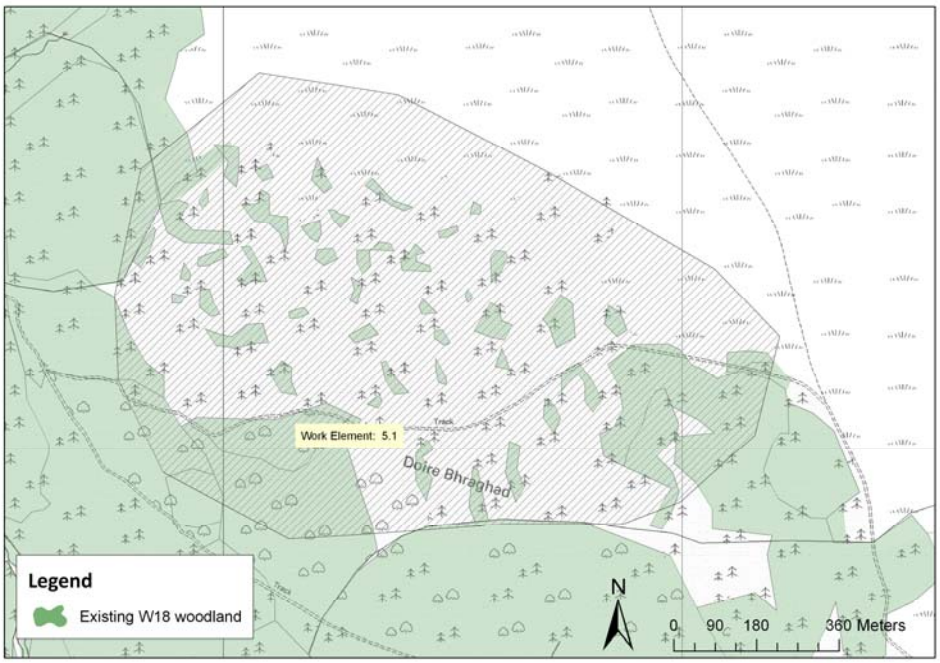

Figure 15 working Circle 5: Glen Lui.

5.1 Encourage natural regeneration recruitment around existing parent trees (between NO069915 and NO078908) by locally intensive site disturbance to create seed bed conditions within 30m of seed source on knolls and driers soils. Avoid the wet pockets and peaty soils that can be found between the dry podsols. Heather may need to be reduced in height before locally intensive site disturbance can be successfully applied; this can be by mechanical swiping or controlled burning. Disturbance needs to be vigorous enough to remove the litter and humus layers to expose the soil horizons below.

Site disturbance should be applied either in the late Autumn (after vegetation growth has ceased) or in early April (before seed fall peaks in May (Edwards, in prep)). Disturbance after peak seed fall will reduce the probability of germination and allow disturbed ground to become re-vegetated before the next seed dispersal period. Suitable protection (ideally fencing) will be required for 20 - 30 years to enable seedlings to establish beyond browsing height. A Black Grouse lek is located within this area (approximately at NO074910) which will need to be protected from any disturbance.

Working circle 6: Glen Lui.

Located on the north and south facing slopes of upper Glen Lui (general grid reference NO051925). Both these new woodlands are necessary to create a habitat network as the current Glen Derry and Glen Luibeg woodlands are isolated from all other native woodland on the Estate. Two main elements of work required.

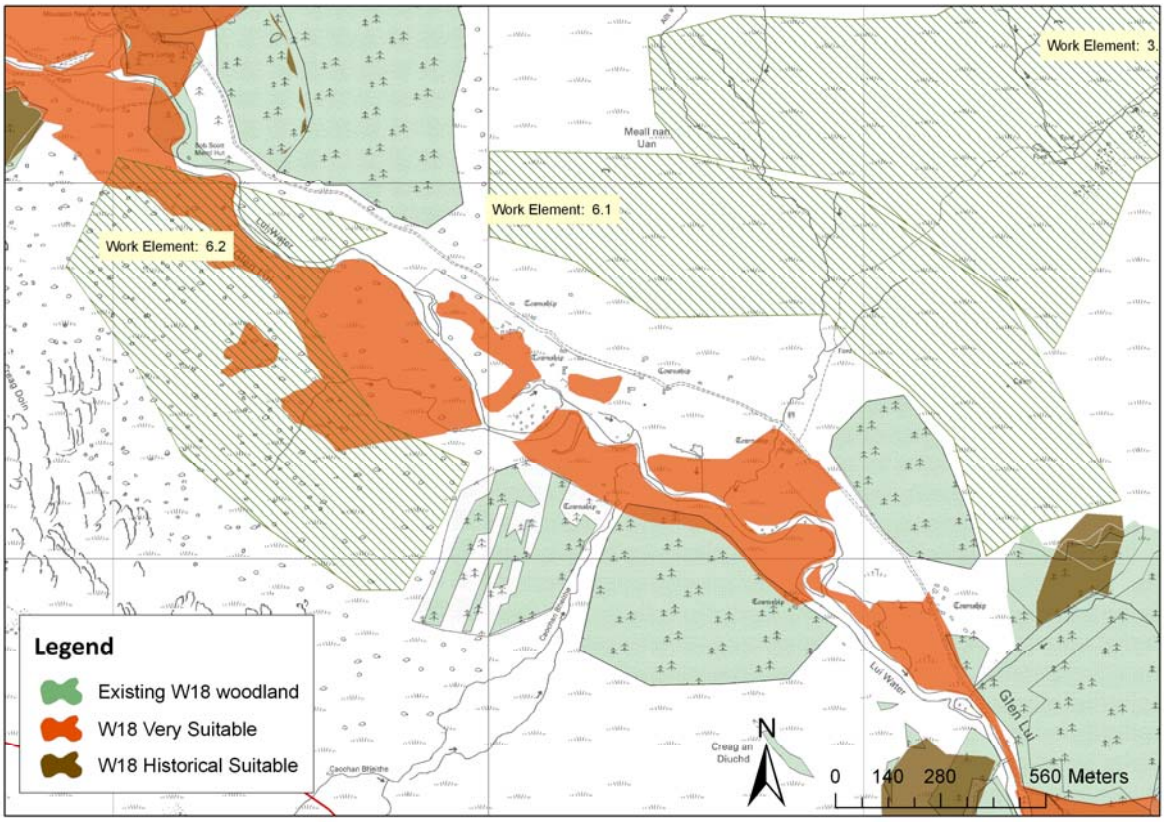

Figure 16 working Circle 6: Glen Lui.

6.1 Establish an area of new native woodland from the existing plantation (NO049931) south eastwards towards and behind the existing plantation (NO061922) towards the native woodland (NO064922). This need not be a single area of woodland, but could be several smaller woodlands established between the existing plantations to create suitable conditions for network connectivity. This area should link with the new woodlands in 3.2 (see above).

6.2 Establish an area of new native woodland from the existing plantation (NO048920) north westwards towards the native woodland at the junction between Glen Derry/Luibeg at (NO038930). On the flat glen bottom exists an area of SAMS archaeology with numerous important historical objects. No establishment would occur within the indicated constraints layer for this location (Figure 17)

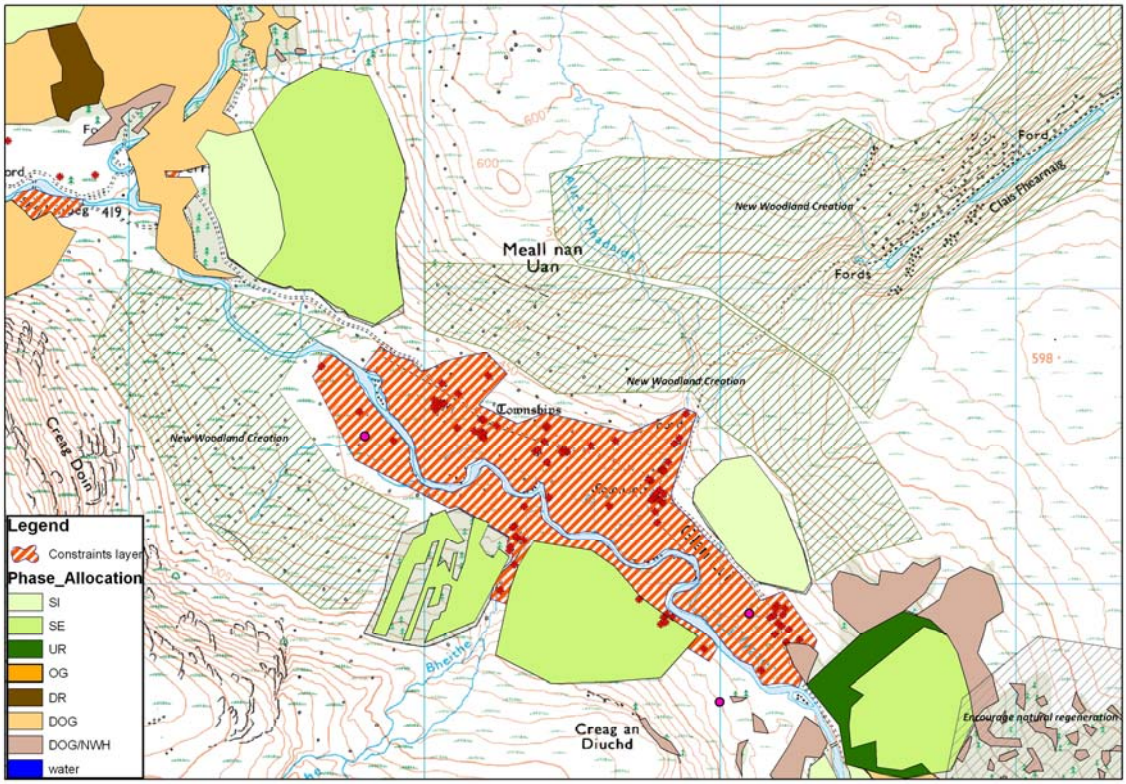

Figure 17 The Glen Lui working circle showing the location of the two areas of suggested new woodland creation, the archaeological constraints area.

Milestones

A number of milestones have been identified, with which progress can be assessed against predictions. These will help design future monitoring assessments to ensure activities are achieving the required results. Each milestone has a suggested date for being achieved, and recommended actions if not being attained.

Work Element	Milestones	Expected date to accomplish	Criteria for success	Recommended action if milestone not achieved
2.1	Scarification completed by. Establishment of natural regeneration at high density in the working circle .	2010 2020	Litter and humus layers disturbed to expose soil for germination. >1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	Scarification of sites to encourage recruitment, and protection from browsing.
2.3	Scarification completed by. Establishment of natural regeneration at high density in the working circle .	2011 2021	Litter and humus layers disturbed to expose soil for germination. >1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	Scarification of sites to encourage recruitment, and protection from browsing.
3.1	Scarification completed by. Establishment of natural regeneration at high density in the working circle .	2011 2019	Litter and humus layers disturbed to expose soil for germination. >1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	Scarification of sites to encourage recruitment, and protection from browsing.
5.1	Scarification completed by. Establishment of natural regeneration at high density in the working circle .	2011 2019	Litter and humus layers disturbed to expose soil for germination. >1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	Scarification of sites to encourage recruitment, and protection from browsing.

General	Recruitment of natural regeneration beneath the existing canopy of seed bearing trees in the regeneration zone.	2012	Variable density recruitment of a range of native species, incidence of browsing damage < 15% of live plants.	Increase culling effort or protect areas through fencing.
1.1	Scarification completed by. Establishment of natural regeneration at high density in the working circle .	2016 2021	Litter and humus layers disturbed to expose soil for germination. >1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	Scarification of sites to encourage recruitment, and protection from browsing.
1.2	Planting completed. Establishment to beginning of canopy closure of artificial and natural regeneration in the working circle .	2016 2027	Local origin planting stock or cuttings established on site. Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
2.2	Planting complete. Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2016 2023	Local origin planting stock or cuttings established on site. Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
4.1	Scarification completed by. Establishment of natural regeneration at high density in the working circle .	2020 2030	Litter and humus layers disturbed to expose soil for germination. >1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	Scarification of sites to encourage recruitment, and protection from browsing.

General	Expansion of natural regeneration onto favourable locations adjacent to existing parent trees.	2020	Variable density recruitment of a range of native species, incidence of browsing damage < 15% of live plants.	Increase culling effort or protect areas through fencing.
4.3	Scarification completed by.	2021	Litter and humus layers disturbed to expose soil for germination.	Scarification of sites to encourage recruitment, and protection from browsing.
	Establishment of natural regeneration at high density in the working circle .	2032	>1,500 stems ha^{-1} of which ≥ 80% show no sign of recent leading shoot browse damage. Average annual increment > 1 cm yr^{-1}. Species composition to include ≥ 50% Scots pine.	
	Planting complete.	2021	Local origin planting stock or cuttings established on site in groups.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
	Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2031	Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	
1.3	Planting complete.	2021	Local origin planting stock or cuttings established on site.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
	Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2032	Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	

4.2	Planting complete. Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2021 2028	Local origin planting stock or cuttings established on site in groups. Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
6.2	Planting complete. Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2026 2033	Local origin planting stock or cuttings established on site in groups. Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
6.1	Planting complete. Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2026 2033	Local origin planting stock or cuttings established on site in groups. Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.
3.2	Planting complete. Establishment to beginning of canopy closure of artificial regeneration in the working circle .	2026 2033	Local origin planting stock or cuttings established on site in groups. Canopy closure is the point at which the crowns of adjacent trees meet and begin to interlock, this is the end of Stand Initiation and beginning of Stem Exclusion.	Protection if failure is browsing damage, fertiliser application to Scots pine (phosphate 2g $tree^{-1}$) if slow growth the main issue.

Acknowledgements

This work was completed with the help, assistance and advice from a wide range of specialists including: Shaila Rao (NTS), Islay Martin (SNH), Chris Hewitt (NTS), Mike Smith (FR), Jordan Chetcuti (FR), Ian Macleod (FR), Mike Perks (FR), Stephen Bathgate (FR).

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EMIS Output for Work Element 1.3.

GB Forestry Decision Support System [Current User : Colin Edwards]

Logout

Objective > Site Details > Site Analysis > Prescription

New Scenario | Change Application | Generate PDF Record

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of options are described in terms of suitability.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data

Grid Reference	Elevation (metres)	Soil Type	Calluna Vulgaris Dominant	Lithology	Slope (%)	Aspect
NO022936	446.0	Podzol, alluvial phase (3v)	No	Granites (high feldspar, low quartz content) (34)	10	Neutral slopes

AT5	CT	DAMS	MD	SMR	SNR	Taylor Class
785.8	6.5	14.7	27.7	Slightly Dry	Very Poor	C

References:

- Ecological Site Classification, Bulletin 124
- Click here to make enquiry to FR ESC team

2. Restock Ground Preparation

2a: Ground Preparation

Objective: To achieve a light mixing of soil and humus, to break up the compacted horizon or hardpan and provide weed suppression.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations / Risks
		No Brash	Light Brash	Heavy Brash			

Trench Mounding							
Hinge Mounding							
Scarification							Brash rake.
Direct Planting SP							Brash rake.
Direct Planting SBI							Brash rake.
Direct Planting DBI							Brash rake.

Developing a Regeneration Management Plan for Mar Lodge Estate Native Woodlands: 2010 - 2030. Colin Edwards.

Notes:

1. When direct planting is given as an option brash management is usually required if it is still present on site.
2. Direct planting may be feasible on wet soils if there is a planting position available between stumps on a plough ridge.
3. Sensitive species (e.g. Douglas Fir) are unsuitable for direct planting on ironpan soils.
4. Demanding species (e.g. Spruces/Firs) are unsuitable for direct planting on podzols due to nutrient limitations .

2b: Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Tracked excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	20	38
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30
4 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	50	20-30
2 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	33	10-20

Notes:

1. Ground conditions considerably affect safe working conditions on slopes.
2. The above table filters machinery according to maximum slope operating limits, occasionally good practice cultivation cannot be applied because of operating constraints.
3. Outputs can be affected by the ability to perform two way working. It may be the case that some machinery will only be safe to use uphill or downhill thus lowering output and increasing cost.
4. Side slope working is NOT RECOMMENDED for tracked or wheeled machines.

2c: Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		?			
Stump removal					

References:

- Cultivation of Soils for Forestry, Bulletin 119
- Forest Ground Preparation, ODW10

- Managing Brash on Conifer Clearfell Sites, FCPN013
- Click here to make enquiry to FR Technical Development team
- Developing a Regeneration Management Plan for Mar Lodge Estate Native Woodlands: 2010 - 2030. Colin Edwards.

3. Species Suitability

3a: Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Growth Factor	Native	Type	Risks
Scots Pine	West		6 (4-6)	AT5	Yes	Conifer	Fungal defoliation
Silver Birch			4 (4-6)	AT5	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b: Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c: NVC - Suitable Native Woodland Types

Woodland Type	Analysis Summary			ESC Factors					
	Suitability	Lim. Factors	Rank	AT5	CT	DAMS	MD	SMR	SNR
W18 Scots pine with heather		-	1						

References:

- Ecological Site Classification, Bulletin 124
- Choice of Sitka Spruce Seed Origins for Use in British Forests, Bulletin 127
- Click here to make enquiry to FR ESC team

4. Wind Hazard

The following information is based on thinned stand with a 2.0 metre initial spacing. Click here to alter stand management practice (note this may also affect yield and timber quality)

The table gives the suggested rotation lengths based on optimal growth/economic modelling and avoidance of Wind Damage Risk Status (WDRS) 6, which is the 10% or higher chance per year of a catastrophic storm causing 35% + windthrow/windsnap in a stand.

	Silviculture	Risk at Rotation	Terminal Height (m)

References:

Developing a Regeneration Management Plan for Mar Lodge Estate Native Woodlands: 2010 - 2030. Colin Edwards.

- FCIN40
- Click here to make enquiry to FR CCF team

7. Fertiliser Guidelines

Species	Nitrogen Prescription	Phosphate Application			Potassium Application			Species Suitability	
		Year Zero	Years 6 to 8	Years 12 to 16	Year Zero	Years 6 to 8	Years 12 to 16	Unfertilised	Fertilised
Scots Pine	None required	Maybe	Maybe	No	No	No	No		
Silver Birch	None required	Maybe	Maybe	No	No	No	No		
Downy Birch	None required	Maybe	Maybe	No	No	No	No		

Notes:

1. Yes - application of this nutrient at this time is recommended for tree establishment.
2. Maybe - application of this nutrient at this time may benefit tree establishment.
3. No - application of this nutrient at this time is not required.
4. When climate is limiting species suitability fertiliser will be ineffective.
5. Retention and redistribution of brash can provide up to 50% or more of year zero nutrient requirements in some cases. This benefit is lost if replanting delayed beyond 18 months from time of felling.
6. Application Rate 100 kg/ha K = 200kg/ha Muriate of Potash.
7. Application Rate 60 kg/ha P = 450kg/ha Rock Phosphate.

References:

- Forest Fertilisation in Britain, Bulletin 95
- Nutrition of Sitka Spruce on Upland Restock Sites in Northern Britain, FCIN47
- Click here to email FR Forest Nutrition Team

8. Plant Quality Guidelines

8a: Plant Specifications

Species	Class	Type	Max REL	Survival at Max. Rel	Height Range (cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a

Downy Birch	Bareroot	Large	35	80	40	8+	n/a

Key

Very suitable period for direct planting

Suitable for planting, dependent upon site conditions

Suitable for planting, dependent upon cold storage

Marginally suitable for planting, depending upon cold storage and site conditions

Unsuitable for planting, expect significant mortality

8b: Planting Windows

Species	Stock Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												
Silver Birch	Bareroot												
Silver Birch	Cell												
Downy Birch	Bareroot												
Downy Birch	Cell												

Notes:

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio for all species should be >1:3, otherwise reject the stock
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring/early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles should be rejected.

References:

- Plant Quality, Bulletin 121
- Testing Plant Quality, FCIN11
- Click here to email FR Plant Quality Team

EMIS Output for Work Element 3.2.

Forest Research

EMIS Report generated by Colin Edwards on 01.12.2009

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of the options are described in terms of suitability or risk according to the following key.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data (Input)

1(a) Site Data	
Site Input Data	**Value**
Grid Reference	NO073938
Elevation (metres)	540.0
Soil Type (FC Code)	Podzol, ericaceous phase (3e)
Calluna Vulgaris Dominant	Yes
Geology/Lithology	Granites (high feldspar, low quartz content) (34)
Slope (%)	15
Aspect	Neutral slopes

1(b) Ecological Site Classification Site Data Analysis						
AT5	**CT**	**DAMS**	**MD**	**SMR**	**SNR**	**Taylor Class**
675.3	6.6	15.6	6.0	Slightly Dry	Very Poor	D

EMIS Output for Work Element 4.2.

2. Site Preparation

2a. Site Preparation

Objective: To achieve a light mixing of soil and humus, to break up the compacted horizon or hardpan and provide weed suppression.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations /Risks
		No Brash	Light Brash	Heavy Brash			
Trench Mounding							
Hinge Mounding							
Scarification							Brash rake.
Direct Planting SP							Brash rake.
Direct Planting SBI							Brash rake.
Direct Planting DBI							Brash rake.

2b. Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Tracked excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	20	38
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30
4 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	50	20-30
2 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	33	10-20

2c. Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		**?**			
Stump removal					

3. Species Suitability

3a Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Factor	Native	Type	Risks
Scots Pine	West		4 (4-6)	AT5	Yes	Conifer	Fungal defoliation
Silver Birch			4 (4-6)	AT5	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c NVC Suitable Woodland Types

Woodland Type	Suitability	Rank	AT5	CT	DAMS	MD	SMR	SNR
W18 Scots pine with heather		1						

7. Fertiliser Guidelines

Species	Nitrogen	Phosphate			Potassium			Species Suitability	
		Year 0	Year 6-8	Year 12-16	Year 0	Year 6-8	Year 12-16	Unfertilised	Fertilised
Scots Pine	None required	Maybe	Maybe	No	No	No	No		
Silver Birch	None required	Maybe	Maybe	No	No	No	No		
Downy Birch	None required	Maybe	Maybe	No	No	No	No		

Notes

1. Yes - application of this nutrient at this time is recommended for tree establishment.
2. Maybe - application of this nutrient at this time may benefit tree establishment.
3. No - application of this nutrient at this time is not required.
4. When climate is limiting species suitability fertiliser will be ineffective.
5. Retention and redistribution of brash can provide up to 50% or more of year zero nutrient requirements in some cases. This benefit is lost if replanting delayed beyond 18 months from time of felling.
6. Application Rate 100 kg/ha K = 200kg/ha Muriate of Potash.
7. Application Rate 60 kg/ha P = 450kg/ha Rock Phosphate.

8. Plant Quality Guidelines

8a Plant Specifications

Species	Class	Type	Max REL	Survival (at max REL)	Height Range(cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Downy Birch	Bareroot	Large	35	80	40	8+	n/a

8b Planting Windows

Very suitable period for direct planting

Suitable for planting, dependent upon cold storage

Suitable for planting, dependent upon site conditions

Marginally suitable for planting, depending upon cold storage and site conditions

Unsuitable for planting, expect significant mortality

Species	Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												

Silver Birch	Bareroot	
Silver Birch	Cell	
Downy Birch	Bareroot	
Downy Birch	Cell	

Notes

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio should be > 1:3, otherwise reject the stock.
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles(forked stems) should be rejected.

EMIS Output for Work Element 3.2 (steep ground)

Forest Research

EMIS Report generated by Colin Edwards on 01.12.2009

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of the options are described in terms of suitability or risk according to the following key.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data (Input)

1(a) Site Data	
Site Input Data	**Value**
Grid Reference	NO069933
Elevation (metres)	507.0
Soil Type (FC Code)	Podzol (3)
Calluna Vulgaris Dominant	No
Geology/Lithology	Granites (high feldspar, low quartz content) (34)
Slope (%)	60
Aspect	Sunny slopes

1(b) Ecological Site Classification Site Data Analysis						
AT5	**CT**	**DAMS**	**MD**	**SMR**	**SNR**	**Taylor Class**
773.0	6.6	19.1	15.7	Slightly Dry	Very Poor	C

2. Site Preparation

2a. Site Preparation

Objective: To achieve a light mixing of soil and humus, to break up the compacted horizon or hardpan and provide weed suppression.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations /Risks
		No Brash	Light Brash	Heavy Brash			
Trench Mounding							
Hinge Mounding							
Scarification							Brash rake.
Direct Planting SP							Brash rake.
Direct Planting SBI							Brash rake.
Direct Planting DBI							Brash rake.

2b. Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30

2c. Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		?			
Stump removal					

3. Species Suitability

3a Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Factor	Native	Type	Risks
Scots Pine	West		4 (<=4)	DAMS	Yes	Conifer	Fungal defoliation
Silver Birch			2 (<=2)	DAMS	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c NVC Suitable Woodland Types

Woodland Type	Suitability	Rank	AT5	CT	DAMS	MD	SMR	SNR
No suitable NVC woodland types								

7. Fertiliser Guidelines

Species	Nitrogen	Phosphate			Potassium			Species Suitability	
		Year 0	Year 6-8	Year 12-16	Year 0	Year 6-8	Year 12-16	Unfertilised	Fertilised
Scots Pine	None required	Maybe	Maybe	No	No	No	No	[redacted]	[redacted]
Silver Birch	None required	Maybe	Maybe	No	No	No	No	[redacted]	[redacted]
Downy Birch	None required	Maybe	Maybe	No	No	No	No	[redacted]	[redacted]

Notes

1. Yes - application of this nutrient at this time is recommended for tree establishment.
2. Maybe - application of this nutrient at this time may benefit tree establishment.
3. No - application of this nutrient at this time is not required.
4. When climate is limiting species suitability fertiliser will be ineffective.
5. Retention and redistribution of brash can provide up to 50% or more of year zero nutrient requirements in some cases. This benefit is lost if replanting delayed beyond 18 months from time of felling.
6. Application Rate 100 kg/ha K = 200kg/ha Muriate of Potash.
7. Application Rate 60 kg/ha P = 450kg/ha Rock Phosphate.

8. Plant Quality Guidelines

8a Plant Specifications

Species	Class	Type	Max REL	Survival (at max REL)	Height Range(cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Downy Birch	Bareroot	Large	35	80	40	8+	n/a

8b Planting Windows

- Very suitable period for direct planting
- Suitable for planting, dependent upon cold storage
- Suitable for planting, dependent upon site conditions
- Marginally suitable for planting, depending upon cold storage and site conditions
- Unsuitable for planting, expect significant mortality

Species	Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												

Silver Birch	Bareroot	
Silver Birch	Cell	
Downy Birch	Bareroot	
Downy Birch	Cell	

Notes

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio should be > 1:3, otherwise reject the stock.
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles(forked stems) should be rejected.

Forest Research

EMIS Report generated by Colin Edwards on 27.11.2009

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of the options are described in terms of suitability or risk according to the following key.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data (Input)

1(a) Site Data	
Site Input Data	**Value**
Grid Reference	NO135921
Elevation (metres)	384.0
Soil Type (FC Code)	Podzol (3)
Calluna Vulgaris Dominant	Yes
Geology/Lithology	Granites (high feldspar, low quartz content) (34)
Slope (%)	10
Aspect	Neutral slopes

1(b) Ecological Site Classification Site Data Analysis						
AT5	**CT**	**DAMS**	**MD**	**SMR**	**SNR**	**Taylor Class**
851.3	6.7	12.7	43.7	Slightly Dry	Very Poor	D

2. Site Preparation

2a. Site Preparation

Objective: To achieve a light mixing of soil and humus, to break up the compacted horizon or hardpan and provide weed suppression.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations /Risks
		No Brash	Light Brash	Heavy Brash			
Trench Mounding							
Hinge Mounding							
Scarification							Brash rake.
Direct Planting SP							Brash rake.
Direct Planting SBI							Brash rake.
Direct Planting DBI							Brash rake.

2b. Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Tracked excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	20	38
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30
4 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	50	20-30
2 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	33	10-20

2c. Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		**?**			
Stump removal					

3. Species Suitability

3a Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Factor	Native	Type	Risks
Scots Pine	West		6 (4-6)	AT5	Yes	Conifer	Fungal defoliation
Silver Birch			4 (4-6)	AT5	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c NVC Suitable Woodland Types

Woodland Type	Suitability	Rank	AT5	CT	DAMS	MD	SMR	SNR
W18 Scots pine with heather		1						

8. Plant Quality Guidelines

8a Plant Specifications

Species	Class	Type	Max REL	Survival (at max REL)	Height Range(cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Downy Birch	Bareroot	Large	35	80	40	8+	n/a

8b Planting Windows

- Very suitable period for direct planting
- Suitable for planting, dependent upon cold storage
- Suitable for planting, dependent upon site conditions
- Marginally suitable for planting, depending upon cold storage and site conditions
- Unsuitable for planting, expect significant mortality

Species	Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												

Silver Birch	Bareroot	
Silver Birch	Cell	
Downy Birch	Bareroot	
Downy Birch	Cell	

Notes

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio should be > 1:3, otherwise reject the stock.
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles(forked stems) should be rejected.

EMIS Output for Work Element 4.3.

Forest Research

EMIS Report generated by Colin Edwards on 27.11.2009

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of the options are described in terms of suitability or risk according to the following key.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data (Input)

1(a) Site Data	
Site Input Data	**Value**
Grid Reference	NO093903
Elevation (metres)	429.0
Soil Type (FC Code)	Podzol (3)
Calluna Vulgaris Dominant	Yes
Geology/Lithology	Quartzose granites and granulites (34)
Slope (%)	25
Aspect	Sunny slopes

1(b) Ecological Site Classification Site Data Analysis						
AT5	**CT**	**DAMS**	**MD**	**SMR**	**SNR**	**Taylor Class**
826.6	6.7	13.6	27.2	Slightly Dry	Very Poor	D

2. Site Preparation

2a. Site Preparation

Objective: To achieve a light mixing of soil and humus, to break up the compacted horizon or hardpan and provide weed suppression.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations /Risks
		No Brash	Light Brash	Heavy Brash			
Trench Mounding							
Hinge Mounding							
Scarification							Brash rake.
Direct Planting SP							Brash rake.
Direct Planting SBI							Brash rake.
Direct Planting DBI							Brash rake.

2b. Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Tracked excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	20	38
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30
4 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	50	20-30
2 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	33	10-20

2c. Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		**?**			
Stump removal					

3. Species Suitability

3a Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Factor	Native	Type	Risks
Scots Pine	West		6 (4-6)	AT5	Yes	Conifer	Fungal defoliation
Silver Birch			4 (4-6)	AT5	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c NVC Suitable Woodland Types

Woodland Type	Suitability	Rank	AT5	CT	DAMS	MD	SMR	SNR
No suitable NVC woodland types								

7. Fertiliser Guidelines

Species	Nitrogen	Phosphate			Potassium			Species Suitability	
		Year 0	Year 6-8	Year 12-16	Year 0	Year 6-8	Year 12-16	Unfertilised	Fertilised
Scots Pine	None required	Maybe	Maybe	No	No	No	No		
Silver Birch	None required	Maybe	Maybe	No	No	No	No		
Downy Birch	None required	Maybe	Maybe	No	No	No	No		

Notes

1. Yes - application of this nutrient at this time is recommended for tree establishment.
2. Maybe - application of this nutrient at this time may benefit tree establishment.
3. No - application of this nutrient at this time is not required.
4. When climate is limiting species suitability fertiliser will be ineffective.
5. Retention and redistribution of brash can provide up to 50% or more of year zero nutrient requirements in some cases. This benefit is lost if replanting delayed beyond 18 months from time of felling.
6. Application Rate 100 kg/ha K = 200kg/ha Muriate of Potash.
7. Application Rate 60 kg/ha P = 450kg/ha Rock Phosphate.

8. Plant Quality Guidelines

8a Plant Specifications

Species	Class	Type	Max REL	Survival (at max REL)	Height Range(cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Downy Birch	Bareroot	Large	35	80	40	8+	n/a

8b Planting Windows

- Very suitable period for direct planting
- Suitable for planting, dependent upon cold storage
- Suitable for planting, dependent upon site conditions
- Marginally suitable for planting, depending upon cold storage and site conditions
- Unsuitable for planting, expect significant mortality

Species	Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												

Silver Birch	Bareroot	
Silver Birch	Cell	
Downy Birch	Bareroot	
Downy Birch	Cell	

Notes

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio should be > 1:3, otherwise reject the stock.
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles(forked stems) should be rejected.

EMIS Output for Work Element 6.1.

Forest Research

EMIS Report generated by Colin Edwards on 01.12.2009

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of the options are described in terms of suitability or risk according to the following key.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data (Input)

1(a) Site Data	
Site Input Data	**Value**
Grid Reference	NO056928
Elevation (metres)	508.0
Soil Type (FC Code)	Podzolic brown earth (1z)
Calluna Vulgaris Dominant	Yes
Geology/Lithology	Granites (high feldspar, low quartz content) (34)
Slope (%)	37
Aspect	Sunny slopes

1(b) Ecological Site Classification Site Data Analysis						
AT5	**CT**	**DAMS**	**MD**	**SMR**	**SNR**	**Taylor Class**
744.7	6.6	15.0	9.6	Slightly Dry	Poor	B

2. Site Preparation

2a. Site Preparation

Objective: To create a weed free planting site, to avoid activating the soil seed bank, to provide frost protection especially on flat inland sites with grassy sward and to impose a discipline on the site.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations /Risks
		No Brash	Light Brash	Heavy Brash			
Trench Mounding							Herbicide.
Hinge Mounding							Herbicide.
Scarification							Brash rake. Herbicide.
Direct Planting SP							Brash rake. Herbicide++.
Direct Planting SBI							Brash rake. Herbicide++.
Direct Planting DBI							Brash rake. Herbicide++.

2b. Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Tracked excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	20	38
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30
4 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	50	20-30

2c. Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		**?**			
Stump removal					

3. Species Suitability

3a Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Factor	Native	Type	Risks
Scots Pine	West		4 (4-6)	AT5	Yes	Conifer	Fungal defoliation
Silver Birch			4 (4-6)	AT5	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c NVC Suitable Woodland Types

Woodland Type	Suitability	Rank	AT5	CT	DAMS	MD	SMR	SNR
No suitable NVC woodland types								

7. Fertiliser Guidelines

Species	Nitrogen	Phosphate			Potassium			Species Suitability	
		Year 0	Year 6-8	Year 12-16	Year 0	Year 6-8	Year 12-16	Unfertilised	Fertilised
Scots Pine	None required	No	No	No	No	No	No		
Silver Birch	None required	No	No	No	No	No	No		
Downy Birch	None required	No	No	No	No	No	No		

Notes

1. Yes - application of this nutrient at this time is recommended for tree establishment.
2. Maybe - application of this nutrient at this time may benefit tree establishment.
3. No - application of this nutrient at this time is not required.
4. When climate is limiting species suitability fertiliser will be ineffective.
5. Retention and redistribution of brash can provide up to 50% or more of year zero nutrient requirements in some cases. This benefit is lost if replanting delayed beyond 18 months from time of felling.
6. Application Rate 100 kg/ha K = 200kg/ha Muriate of Potash.
7. Application Rate 60 kg/ha P = 450kg/ha Rock Phosphate.

8. Plant Quality Guidelines

8a Plant Specifications

Species	Class	Type	Max REL	Survival (at max REL)	Height Range(cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Downy Birch	Bareroot	Large	35	80	40	8+	n/a

8b Planting Windows

Very suitable period for direct planting

Suitable for planting, dependent upon cold storage

Suitable for planting, dependent upon site conditions

Marginally suitable for planting, depending upon cold storage and site conditions

Unsuitable for planting, expect significant mortality

Species	Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												

Silver Birch	Bareroot	
Silver Birch	Cell	
Downy Birch	Bareroot	
Downy Birch	Cell	

Notes

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio should be > 1:3, otherwise reject the stock.
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles(forked stems) should be rejected.

EMIS Output for Work Element 6.2

Forest Research

EMIS Report generated by Colin Edwards on 27.11.2009

Information

The site data and analysis are described in the following sections. Unless otherwise stated the effectiveness of the options are described in terms of suitability or risk according to the following key.

Key

Very Suitable, low risk option

Suitable, medium risk option

Unsuitable, high risk option

1. Site Data (Input)

1(a) Site Data	
Site Input Data	**Value**
Grid Reference	NO044924
Elevation (metres)	433.0
Soil Type (FC Code)	Podzol (3)
Calluna Vulgaris Dominant	Yes
Geology/Lithology	Quartzose granites and granulites (34)
Slope (%)	14
Aspect	Neutral slopes

1(b) Ecological Site Classification Site Data Analysis						
AT5	**CT**	**DAMS**	**MD**	**SMR**	**SNR**	**Taylor Class**
814.9	6.6	11.4	34.1	Slightly Dry	Very Poor	D

2. Site Preparation

2a. Site Preparation

Objective: To achieve a light mixing of soil and humus, to break up the compacted horizon or hardpan and provide weed suppression.

Method	Suitability	Density and Uniformity			Hylobius	Weed Suppression	Other Operations /Risks
		No Brash	Light Brash	Heavy Brash			
Trench Mounding							
Hinge Mounding							
Scarification							Brash rake.
Direct Planting SP							Brash rake.
Direct Planting SBI							Brash rake.
Direct Planting DBI							Brash rake.

2b. Machinery for Good Practice Ground Preparation

Machine Name	Available Methods	Downhill Range(%)	Uphill Range(%)
Tracked excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	20	38
Walking excavator	Brash rake/Trench Mound/Hinge Mound/Screef(Scarification)	60-70	60-70
8 Wheeled forwarder	Disc scarification/Continuous Mounding	65	30
4 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	50	20-30
2 Wheel drive forestry tractor	Brash rake/Patch or Disc Scarification	33	10-20

2c. Brash/Stump Management Impact

Operation	Ground Damage	Soil Carbon Loss	Soil Infertility	Soil Acidification	Combined Risk
Brash removal		?			
Stump removal					

3. Species Suitability

3a Summary Species Analysis

Species	Provenance	Suitability	Yield Index	Limiting Factor	Native	Type	Risks
Scots Pine	West		6 (4-6)	AT5	Yes	Conifer	Fungal defoliation
Silver Birch			4 (4-6)	AT5	Yes	Broadleaf	
Downy Birch			2 (<=2)	SMR	Yes	Broadleaf	

3b Detailed Species Analysis

Species	AT5	CT	DAMS	MD	SMR	SNR
Scots Pine						
Silver Birch						
Downy Birch						

3c NVC Suitable Woodland Types

Woodland Type	Suitability	Rank	AT5	CT	DAMS	MD	SMR	SNR
W18 Scots pine with heather		1						

7. Fertiliser Guidelines

Species	Nitrogen	Phosphate			Potassium			Species Suitability	
		Year 0	Year 6-8	Year 12-16	Year 0	Year 6-8	Year 12-16	Unfertilised	Fertilised
Scots Pine	None required	Maybe	Maybe	No	No	No	No		
Silver Birch	None required	Maybe	Maybe	No	No	No	No		
Downy Birch	None required	Maybe	Maybe	No	No	No	No		

Notes

1. Yes - application of this nutrient at this time is recommended for tree establishment.
2. Maybe - application of this nutrient at this time may benefit tree establishment.
3. No - application of this nutrient at this time is not required.
4. When climate is limiting species suitability fertiliser will be ineffective.
5. Retention and redistribution of brash can provide up to 50% or more of year zero nutrient requirements in some cases. This benefit is lost if replanting delayed beyond 18 months from time of felling.
6. Application Rate 100 kg/ha K = 200kg/ha Muriate of Potash.
7. Application Rate 60 kg/ha P = 450kg/ha Rock Phosphate.

8. Plant Quality Guidelines

8a Plant Specifications

Species	Class	Type	Max REL	Survival (at max REL)	Height Range(cm)	RCD Range (mm)	Minimum Volume (cc)
Scots Pine	Cell		30	80	15-30	3-5	200
Scots Pine	Bareroot	Small	25	80	8-12	4+	n/a
Scots Pine	Bareroot	Large	25	80	12+	4.5+	n/a
Scots Pine	Bareroot	X-large	25	80	20+	5+	n/a
Silver Birch	Cell	-	40	80	20-40	4-6	100
Silver Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Silver Birch	Bareroot	Large	35	80	40	8+	n/a
Downy Birch	Cell	-	40	80	20-40	4-6	100
Downy Birch	Bareroot	Small	35	80	20-40	4-5	n/a
Downy Birch	Bareroot	Large	35	80	40	8+	n/a

8b Planting Windows

- Very suitable period for direct planting
- Suitable for planting, dependent upon cold storage
- Suitable for planting, dependent upon site conditions
- Marginally suitable for planting, depending upon cold storage and site conditions
- Unsuitable for planting, expect significant mortality

Species	Stock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scots Pine	Bareroot												
Scots Pine	Cell												

Silver Birch	Bareroot	
Silver Birch	Cell	
Downy Birch	Bareroot	
Downy Birch	Cell	

Notes

1. Quality of planting strongly influences survival and long term growth.
2. The root:shoot ratio should be > 1:3, otherwise reject the stock.
3. Planting outside recommended windows will usually incur a loss of 10% or more. Late spring early summer planting is especially vulnerable to drought conditions.
4. Plant quality should be assessed on receipt, stock comprising doubles(forked stems) should be rejected.